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13. ABSTRACT (Maximum 200 Words)

To bring together some of the best minds in the field of Human Factors as it relates to Telemedicine. The group explored how the utilization rates can be improved and documented the thinking in the form of a book that will be valuable to the military health care system and to scholars.

Bangert/Doktor, Inc. managed a virtual learning community that interacted continually for two years using the Internet and attended two meetings sponsored by TATRC, devoted to the theme *Human Factors in Telemedicine*. At the first meeting the invitees committed to the production of a book. At the second meeting, they explored general topics and discuss their individual "thought pieces." During the entire contract period, the invitees refined, discussed and prepared their articles. By electronic discourse, final drafts will be exchanged and discussed. Outside reviewers were used. Dominant themes identified. The editors finalized the articles, organized the edited edition, and prepared the necessary introductory and conductive passages.

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Introduction

Bangert/Doktor, Inc. has solicited articles from leading experts world wide on the practice and successful implementation of telemedicine with relate to human factors. Forty-eight contributors from eight different countries have prepared articles as contributions to the book. The preparation process for most included three drafts that were reviewed by the editors, other contributors and outside experts. In addition, the editors selected a classic article for each section. The classic articles are seminal works upon which the contributors based their theoretical discussion.

Body

The overall goal of this two-year contract was to produce a book about human factors in telemedicine and e-Health. The title is *Human and Organizational Dynamics in e-Health.* This goal was met. The book has been accepted by Radcliffe Publishing and is being processed by its staff.

Overview and Description

Telemedicine is at the forefront of clinical e-health systems. Globally, both in government and private sectors, professionals agree that telemedicine is a good idea and here to stay; most agree it is central to the future delivery of health care services. Yet, many stakeholders report that telemedicine seems more like a failure than a success. In case after case, soon after the implementation of telemedicine, the utilization and interest curves skate downhill – sometimes to the point where the system remains unused. While there are notable exceptions to this trend, the reported failures of telemedicine foster a reputation that distinctly challenges leaders who seek to adopt this promising technology. Further, the same dynamics relevant to the adoption of telemedicine may foreshadow adoptions of different and/or more advanced clinical e-health technology to come.

Across cultures, failures are disheartening, especially for advocates of the efficacy of telemedicine and other clinical e-health solutions. To them, telemedicine clearly presents a constellation of opportunities, some of which are: to increase access to health care of the highest quality; to improve the quality of health care by providing earlier, more effective interventions; to improve the quality of healthcare by providing a mechanism for continuing clinical learning and rapid, widespread knowledge dissemination . And, intuitively, despite a recent study in *British Medical Journal* that concludes "there is no good evidence that telemedicine is a cost effective means of delivering health care." healthcare professionals believe that telemedicine holds the promise of decreasing the cost of health care services.

Why do so many telemedicine systems fail? What are the dynamics underlying the failure to thrive; how can we preclude such failure? Why is success so rare? What enables the successes and what can we learn from them? Research, especially the examination of the impact of organizational and individual dynamics on telemedicine,

may hold the answers to these questions, not only for telemedicine but also for clinical e-health systems in general.

Normally, the root of telemedicine failure (relative to cost-effectiveness) is not the technology, but rather the human system in which the technology is implanted. When the technology is not utilized to its potential, a low number of interactions is expensed to the initial investment; the program is thus deemed too costly. Insufficient utilization is central to the failure of telemedicine: the source is neither consumer acceptance nor inadequate technology. The utilization problem is a human dynamic expressing an interesting ambiguity: healthcare providers accept the new delivery system as a good development and yet resist using it. The organizational and individual resistance may come from human-machine interface, change in organizational processes and culture, individual behavior, clinical conditions, and user preconceptions of telemedicine. Any of these dynamics within the field of human factors may stem the drop in the utilization rates to the point where cost is excessive.

This book is dedicated to understanding and resolving organizational and individual resistance to telemedicine, and prescribes specific solutions that are inordinately relevant to current challenges -- as well as to more complex clinical e-health technology of the future. The book's international comparative perspective fuels the discovery and transfer of the wisdom of diverse cultures to all others.

Facilitating utilization is a key to unlocking the potential of e-health technology. Understanding and managing people within an organization during a change of technology such as telemedicine is a complex, interactive and systemic challenge. Particularly since the reality of being able to isolate and control one aspect of an issue without impacting other aspects is highly unlikely. High rates of utilization of telemedicine significantly reduce the cost per consult and result in telemedicine being viewed as a success by healthcare leaders which then allows continuation, innovation, increased access, improved quality, and reduction of the overall cost of health care. Understanding, mediating, and managing complex human factors in the adoption of clinical e-health solutions is thus essential to the evolution of global healthcare.

Outline

In this book we identify human and organizational factor issues in clinical e-health utilization. And, we acknowledge that such artificial, analytic decomposition and disintegration belies the true interconnectedness and interactivity of the health care social system.

Having made this disclaimer, we proceed to deconstruct the real world, international phenomena of acceptance/resistance to telemedicine and construct culturally competent strategies to overcome individual and organizational resistance to such e-health technology.

We conceptualize the challenge of managing successful telemedicine and e-health adoptions as peeling an onion. Revealing (understanding) each layer contributes to achieving success at the core. In this book, we peel off each layer successively, examining each before proceeding, always recognizing that these layers are constructions of our own minds; they are helpful in our understanding of nature, but are not the reality of nature. (The map is not the territory.) The reality lies in the natural symbiosis of all these aspects as coherent whole. Thus, we view the issue as depicted in Figure 1.

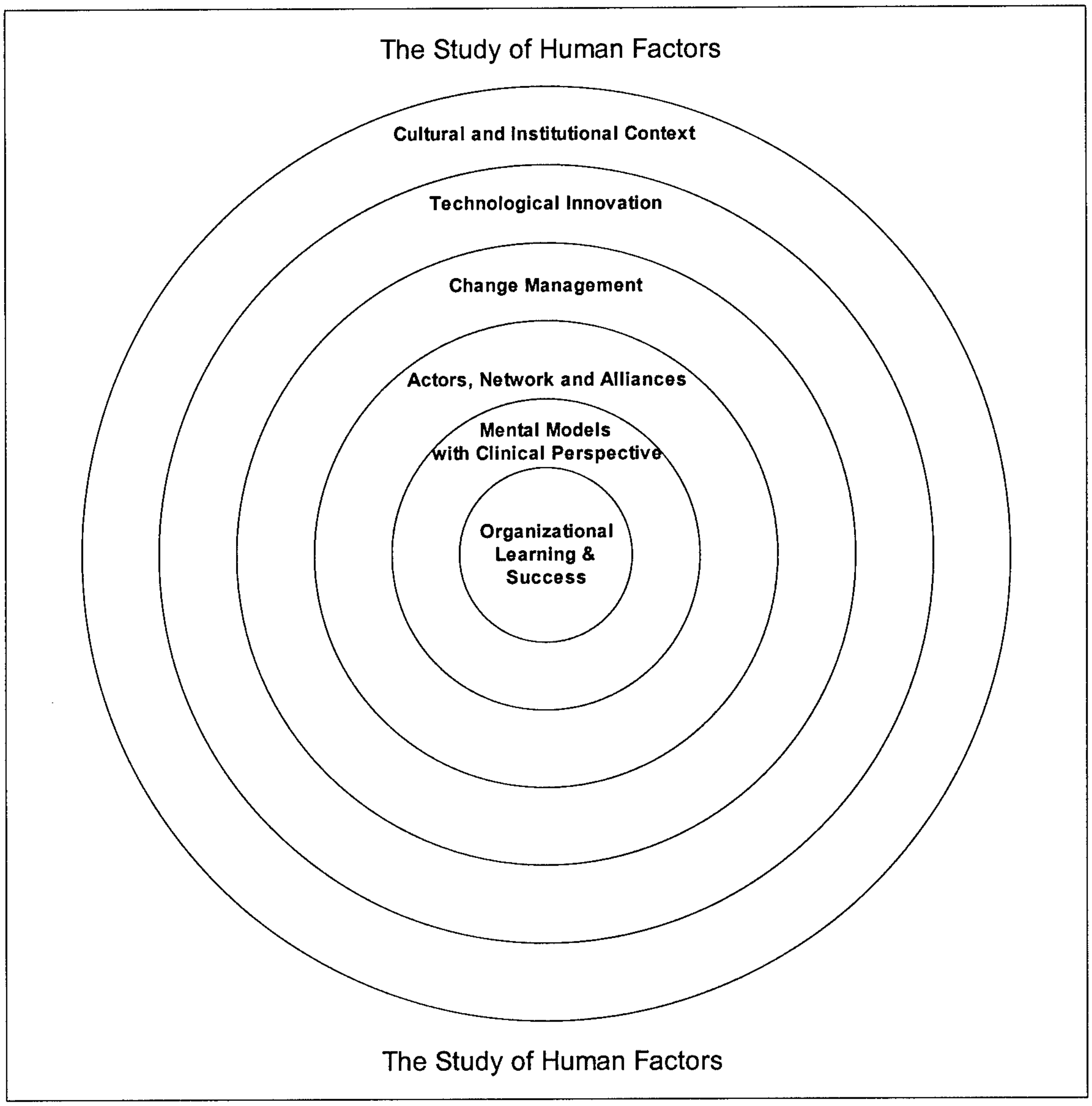

Figure 1

The design of our book seeks to present the best expert analysis of each layer of the onion in Figure 1, and to explore each layer in consideration of concurrence, sequence,

and integration with each and all other layers. That is, while each expert may emphasize one layer of the onion, s/he is encouraged to make note of its interactivity with all others. S/he may discuss it within any or all of the subfields of management and organization. Contributions from the experts may be the result of rigorous investigation, thought pieces, reviews of literature, or case studies. In addition to these expert contributions, included in discussion of each layer are "classic" articles from the broader literature on the adoption of technology and the impact of the resulting changes on the organization. Expert referrals to the "classics" will be tied to the current state of e-health and overarching principles of management and organization in editorial commentary.

In the seven sections of the edited volume, we strive to answer the following questions:

Section 1: Overview of Human Factors in Healthcare Technology Utilization
In its broadest sense, the field of Human Factors has much to contribute to our understanding of implementation and long term utilization of new technologies in Healthcare. This section categorizes and reviews traditional Human Factor approaches applicable to the technology utilization problem in e-health implementations.

Section 2: Cultural and Institutional Context of Telemedicine & e-Health
What cultures -- national, professional or organizational -- are receptive or resistant to telemedicine? What interventions are appropriate to change the cultures to facilitate a successful program? What core values those make the adoption of telemedicine successful?

Section 3: Technological Innovation in Telemedicine & e-Health
What role does innovation play in successful telemedicine? Is there a role for disruptive technologies in healthcare? What "proof" does a health care professional need in order to embrace a new technology? What actions and structures can promote high acceptance of new technologies in health care organizations?

Section 4: Managing Change in Telemedicine & e-Health
What role must a leader and/or manager play in the successful adoption of telemedicine? What support processes must be in place for an organization to accept telemedicine? How does one introduce new equipment in a healthcare setting?

Section 5: Actors, Networks and Alliance in Telemedicine & e-Health
What alliances between various actors impact or preclude the success of e-health utilization? How may alliances be constructed to promote enhanced utilization? In addition to human actors, non-human entities such as software programs may also be considered actors in networks of alliances. How can these networks be modified so as to achieve greater stability in these processes of e-health utilization?

Section 6: Mental Models and the Clinical Perspective in Telemedicine & e-Health
What standards of proof are necessary for a healthcare professional to use telemedicine? Has professionalization created fixed perspectives and mental models that limit health care providers' ability to perceive the full range of benefits derived from

telemedicine? Values as well as models of causality may be heavily influenced by the enculturation of professional training. How may such dysfunction be focused toward successful utilization of e-health systems?

Section 7: Organizational Learning and Success in Telemedicine & e-Health
What role, if any, does organizational learning play in the adoption of telemedicine? What other learning results from telemedicine? How cultural dynamics affect organizational learning? What are typical learning characteristics of health care organizations, and how might these inhibit or enhance of e-health implementation? Is there a need to balance or match learning values of the organization to those values embedded in the general society that the e-health system impacts?

Targeted Readers
The book targets five segments of readers: healthcare administrators, healthcare policy researchers, healthcare clinicians, information technology professionals, and government stakeholders and other healthcare funders. Healthcare is the largest service industry in the United States. It is in trouble: cost is running out of control; the population expects government to control its rising costs; government tries to pass the costs to industry; industry, in turn tries to pass it on to its workers. Comparisons of costs verses healthcare outcomes and results in other cultures, as for example in some European nations, raise questions in the minds of American policymakers and citizens with regard to the current management and organization of healthcare in the USA.

Healthcare and information system professionals, who are dedicated to the provision of healthcare, are seeking the types of productivity gains that other US industries are achieving through information technology. Thus, the level of interest in e-health soars!

Clinicians pressure healthcare administrators to provide the clinical technology and support services that they believe will facilitate such positive changes as increasing access, improving quality, and lowering costs. In response to investment in such expensive technology, many of the same physicians who make the demands then resist using the technology. This book will give the administrators new insight into how the physicians can be influenced to fully own and utilize e-health innovation.

Healthcare policy researchers are consistently seeking quality scholarship that assists them in the undaunting task of fueling policy decision-making. This book will provide them with a comprehensive treatment of best thinking and leading edge research in the management and organization of clinical e-health not available elsewhere.

Healthcare clinicians -- physicians, physician assistants, nurses and technicians – feel they are on a treadmill. As consumers' expectations continue to rise, finding appropriate (disruptive) technology seems the best leap off the accelerating treadmill. This book will show these clinicians how to help their colleagues and organizations to embrace e-health initiatives.

Because of the strong professional cultures within healthcare, information technology professionals find it an especially challenging industry in which to work. Not only are the healthcare cultures strong, they are different from the professional culture of information technology professional. Therefore, even through the IT professionals may feel the culture clash, they do not know how to respond to it. This book will help IT professionals work in any industry where the industry's professional culture is different from the IT culture.

Government and other healthcare funders, struggling to define appropriate, outcome-driven allocations need to understand how to be the best funding/resource partners possible. This book will give these stakeholders the fuel they need to understand how funding human factor context improvements need to be a strategic, companion investment to technology advancement.

Articles in the book are:

Section 1: Overview of Human Factors in Healthcare Technology Utilization
Aideen Stronge, Timothy A. Nichols, Jeanette Rasche, Rufus Sessions, A.D.. Fisk, and Wendy Rogers
"An Application of Human Factors Methods to Teledermatology"
CLASSIC:
Marilyn J. Field, Editor
"Human Factors and the Acceptance of Telemedicine" based on a background paper drafted by John C. Scott and Neal I. Neuberger. This was located in Chapter 4 "The Policy Context of Telemedicine" in *Telemedicine: A guide to Assessing Telecommunications in Health Care.*

Section 2: Cultural and Institutional Context of e-Health
Jim Katzenstein and Barbara Chrispin
"Designing a Telemedicine System in Tanzania – A Sociotechnical Systems Approach"
Deena Suresh and Sridhar CB
"E-health for doctors in rural and urban India"
CLASSIC:
Geert Hofstede
"Cultural Constraints in Management Theories"

Section 3: Technological Innovation in e-Health
Ville Harkke and Mikael Collan
"Structures Surrounding e-Health: Effects of Legal and Administrative Structures on Development of IT in Health Care Services – focus on Finland"
John Fulcher
"The Use of Patient Biometrics in Accessing Electronic Health Records"
Lynne Baldwin and Malcolm Clarke
"Using ICT to Better Support the Fragmentary Nature of Healthcare"

CLASSIC:

Clayton M. Christensen, Richard Bohmer, and John Kenagy
"Will Disruptive Innovations Cure Health Care?"

Section 4: Change Management in e-Health

Ton Spil, Roel W. Shuring, and Margreet B. Michel-Verkerke
"Do Healthcare Professional USE IT"

Kawaljeet Kaur, Cynthia Scheideman-Miller, Lori Smith and Pam Forducey
"Implementation of a Telerehabilitation System Using Change Management Principles"

CLASSIC:

John R. Kimberly and Michael J. Evanisko
"Organizational Innovation: The Influence of Individual, Organizational, and Contextual Factors on Hospital Adoption of Technological and Administrative Innovations."

Section 5: Actors, Networks and Alliance in e-Health

Debbie Justis, Charles Doarn, and Ronald Merrell
" The Three Rivers Telehealth Network: Creation of a Distributed Network."

David Bomba
"A Comparative Study of the Diffusion of Computerized Health Records among General practitioners in Australia and Sweden"

Deborah Seale, Sally Robinson, Alexia Green, Glenda Walker, Bobbye Berg, Christina Esperat, Patty Ellison, and Michael Chalambaga
"Developing Strategic Alliances for Telemedicine"

CLASSIC:

Luke, Roice D., James W. Begus, and Dennis D. Pointer"Quasi Firms: Strategic Interorganizational Forms in the Health Care Industry."

Section 6: Mental Models and the Clinical Perspective in e-Health

Colin Mackenzie, Yan Xiao, David Lam, Peter Hu, and Claudia Oglivie
"Telemedicine in Emergencies"

Nancy Johnson, Rita Webb, Steve Moser, Rosanne Harrigan, and Jean A. Pezzoli
"Telehealth Advances for Diabetes"

Robert Bulik, Sherry Wulff, Kathleen K. Bultman, Thomas J. Pfeil
"Evaluating the Human Dimension of Primary Care Telemedicine Encounters"

CLASSIC:

Paul J. Hu, Patrick Y.K. Partrick Y.K., Olivia R. Lui Sheng, and Kar Yan Tam
"Examining the Technology Acceptance Model Using Physician Acceptance of Telemedicine Technology"

Section 7: Organizational Learning and Success in e-Health

Monrad Aas

"ICT Supported Cooperative Network"

David Bangert and Robert Doktor

"Organizational Learning and Culture in the Managerial Implementation of Clinical e-health Systems: An International Perspective"

CLASSIC:

David F. Robinson, Grant T. Savage and Kim Sydow Campbell

"Organizational Learning, Diffusion of Innovation and International Collaboration in Telemedicine"

Key Research Accomplishments

The research accomplishments are the separate articles in the appendix. These are:

- Aideen Stronge, Timothy A. Nichols, Jeanette Rasche, Rufus Sessions, A.D.. Fisk, and Wendy Rogers, "An Application of Human Factors Methods to Teledermatology"
- Jim Katzenstein and Barbara Chrispin, "Designing a Telemedicine System in Tanzania – A Sociotechnical Systems Approach"
- Deena Suresh and Sridhar CB, "E-health for doctors in rural and urban India"
- Ville Harkke and Mikael Collan, "Structures Surrounding e-Health: Effects of Legal and Administrative Structures on Development of IT in Health Care Services – focus on Finland"
- John Fulcher, "The Use of Patient Biometrics in Accessing Electronic Health Records"
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- Debbie Justis, Charles Doarn, and Ronald Merrell, " The Three Rivers Telehealth Network: Creation of a Distributed Network"
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- Colin Mackenzie, Yan Xiao, David Lam, Peter Hu, and Claudia Oglivie, "Telemedicine in Emergencies"
- Nancy Johnson, Rita Webb, Steve Moser, Rosanne Harrigan, and Jean A. Pezzoli "Telehealth Advances for Diabetes"
- Robert Bulik, Sherry Wulff, Kathleen K. Bultman, and Thomas J. Pfeil, "Evaluating the Human Dimension of Primary Care Telemedicine Encounters"
- Monrad Aas, "ICT Supported Cooperative Network"

- David Bangert and Robert Doktor, "Organizational Learning and Culture in the Managerial Implementation of Clinical e-Health Systems: An International Perspective"

Reportable Outcomes
The articles which are contained in the appendices are the major outcomes.

Conclusions
The book was completed as required by the contract.

References
None

INTRODUCTION

Many Americans, now over sixty years of age, may think back nostalgically to the medical care we received as a youth. Perhaps the memories are similar to Bob's: he recalls lying on the living room couch, bundled in soft blankets, in his lower-middle class home in the suburbs. When reporting a sore throat in the evening, his mother would say: "No school for you tomorrow; I'm calling Dr. Siegel!" In the morning, Mother would call the school principal's office at 7: 30 a.m., "Bob is sick and will be absent from school today." She'd call Dr. Siegel at 8:30 a.m., during his morning call hour. The doctor would answer the phone himself. Mother would explain the situation: temperature 103°, sore throat, can't swallow. Dr. Siegel would say: "I'll be there at 2."

At 2:30 p.m. Dr Siegel's Jaguar sedan would appear in Bob's driveway. With black bag in hand, Dr Siegel would walk up the steps, ring the doorbell, and find Mother there to greet him at the front door. He looked for the patient while standing on tip toes -- for Dr. Siegel was but 5'3". This same doctor had delivered Bob eleven years before at Memorial Hospital.

Mother would lead Dr. Siegel to the sick bed. Out of the black bag came a thermometer and a stethoscope: "Open wide" he'd say, and in would go the thermometer. "Take a deep breath and hold it" would be the warning as the cold steel of the stethoscope touched skin. He would feel Bob's neck for swelling. "Open wider" echoed as that terrible wooden tongue depressor thrust toward the sore throat. A look at the thermometer: "Looks like it might be strep so I'm going to give him a shot. Have him gargle with warm water and salt, and here is a prescription to get at the pharmacy." he'd say while scribbling a prescription on a pad. "Take one teaspoon every eight hours for

seven days; Bobby should be better in 48 hours. If he still has a fever above 99 on Wednesday morning, please call me between 8 and 9 am. If you want to, he can have up to two aspirins a day; one in the morning and one before bedtime."

Dr. Siegel would then collect his gear as Mother would scurry to the bedroom returning with cash in hand. She would give Dr. Siegel $25. There was no insurance, no paperwork, and no government red type. He would put the money in his wallet and Mother would see him out.

As Bob watched the good doctor leave, pining for a ride in that baby blue Jaguar with the white leather seats, Mother would telephone Schmidt's Pharmacy, three blocks away. Mr. Schmidt would send Ray, the delivery boy, on his bike, to the house with the prescription before 4 p.m. Ray would pick up the prescription paper and the $4.95 for the liquid. Mother gave Ray $5.25 -- inclusive of a thirty cent tip!

All in all it, the medical treatment cost $30.25 – not cheap! That two bedroom, one bath home, two years earlier, was purchased for $11,000. Money was tight. All in all, from the awareness of the illness to the medical advice spanned 19 hours, the initial set of likely needed medication came 21 hours after awareness. Bob was well and back to a normal routine 60 hours after initial awareness of illness.

That healthcare of 50 years ago was good! We were satisfied consumers! Dr. Siegel was financially comfortable and Pharmacist Schmidt drove a Cadillac Eldorado. Ray thought $0.30 a good tip. Mr. Schmidt was paying him $1.00 per hour. Ray already planned on becoming a doctor when he grew up. Life was good.

Things are different now. Consider a typical scenario in Hawaii 2004. Both of Leilani's parents are financially comfortable college teachers. Their house is big; it's on a golf course and only 200 meters from a beautiful beach.

Leilani reports a sore throat at 7 p.m., Mother says: "I'll call Dr. Sia in the morning." His office is 13 miles away, downtown at Kapiolani Medical Center. As a participating doctor in the family's Blue Cross/ Blue Shield medical plan, costs can be kept down. Lei's parents pay (with their employer) $575 per month for health insurance for the family of 3. There are some non-participating pediatricians nearer the family home, but to go to them might add $200-300 to the bill. Dr. Sia is considered one of the best around and Leilani's parents are happy he has room in his practice for her.

At 7:30 am, Mother calls the school to say Leilani will be absent; she calls Dr. Sia's office at 8:30. The recording states: "Please leave your name and telephone number and a short message as to your problem. We will call you back as soon as we can." At 9:45 the phone rings. Mother explains that Leilani complained of a sore throat and had a fever of 103° last evening. The lady calling says you can not bring Leilani in right away because mornings are reserved for well-baby check ups. She can try to fit Leilani in that afternoon -- around 3 pm.

Mother packs up 11 year old Leilani at 2 pm; the drive takes 45 minutes; -- traffic is normal. Arriving at the parking garage at 2:45, Mother takes a parking ticket from an automated machine and carefully puts it in her purse to avoid penalties of $15 to $20 for losing a ticket or not having it stamped. All the spaces on the first and second floor of the garage are reserved for doctors and staff and they seem to be all full of Mercedes. Between cars backing out, cars taking many moves to get into tight spaces, and full

parking spaces on all floors, it takes Mother 20 minutes to land a space on the ninth floor of the garage. It is now 3:05 pm. so Mother rushes Leilani out of the car. They hurry to the garage elevator, for they are now late for their 3 p.m. emergency appointment. The elevator is slow and stops many times on its way down. Getting on at floor 5 is a women carrying a baby and dragging a sick young boy (coughing and coughing and coughing). Mother and Leilani finally get out and rush down the hallway at 3:15. In all the waiting rooms along the way, patients are coughing and sneezing -- it must be flu season.

Mother and Leilani finally reach the elevator to the medical offices! Pediatricians are all on the 9^{th} floor. There is a large crowd at the elevator door area and lots more coughing! When the elevator finally arrives, Mother and child pile in to a full elevator and a loud buzzing begins. Knowing that someone has to get out, an older gentleman with a cane smiles and departs. The elevator is again on the move, but stops at floors 2, 3, 4, 5, 6, 7, and finally 9. Out they go, down the hall, left and into Dr. Sia's waiting room. It is now 3:25 p.m. The nurse looks at mother and child, looks at the clock, raises her eyes and clicks a note of disdain. Mother explains that they arrived at the medical center at 2:45 but parking was a problem. The nurse responds: "Tell me about it. I have to park at a lot 4 blocks away. And they charge me $250 a year for that!"

The nurse tells Mother and child to take a seat. Mother takes a seat by the nurse's desk and directs Leilani to take the only other empty one across the room. One boy, the cougher from the garage elevator, is about her age. Mother took off work today, so she calls the office to be sure that her class "Intro to Geography" will be "covered" by a colleague. Her secretary says all is well, "But stop by the University before 5 p.m. to

sign some papers for next years book orders that are due today." Because it is now only 3:35, Mother says "Of course"; the University is only a 10 minute drive from the Medical Center.

Four o'clock comes and goes. At 4:45 the nurse finally calls Leilani's name and escorts them to a small room for the examination. A nurse takes Lei's temperature, blood pressure and asks questions of the problem. She makes notes on a form, and says: "Dr. is running a little late, make yourselves comfortable."

At 5:15 Dr. Sia appears – cheery as ever. "Hi Leilani, what's up?" Lei tells of her sore throat. Dr. Sia feels her throat and uses a wooden tongue depressor to press her tongue down. With a cotton swab, he takes a sample from the reddened area. "OK Leilani, we will have to check this out – see if it is strep or a virus" he counsels. "Lots of viruses going around. We should get the results back in two days. See the nurse and schedule a follow-up on Wednesday afternoon" the good Dr. orders.

When Mother explains that Leilani had a high temperature the night before, Dr. Sia suggests Tylenol for the fever. He explains that viruses are not affected by antibiotics -- lab results are needed before prescriptions can be made. Giving antibiotics inappropriately could lead to resistant strains of bacteria. And that is a problem for all of us.

Mother reschedules for 4pm Wednesday. The lab will be ready by noon on Wednesday. Mother and Lei leave. At 5:30 to find the exit to the parking garage backed up. Mother forgot to get the parking ticket stamped, so at 5:45, the parking attendant says: "$15 please". With traffic in rush hour mode, an exhausted Mother and child get home at 7 p.m. Mother calls on an old family ritual and gives Leilani a cool bath to bring

the fever down. One child's Tylenol, a bowl of soup, and Lei is off to bed. Mother forgot the 5 p.m. deadline to sign papers at her work. As a consequence, books for her class next semester will arrive 10 days after the class begins, causing all kinds of complaints from her students, and from her department chair.

Leilani's condition seems worse on Tuesday morning, but after another cool bath, some soup and Tylenol, she is OK with a temperature of 102°. She was miserable on Tuesday night as were Mother and father. Their little girl was sick, and all they could do was provide love, a cool bath, soup and Tylenol. Mother now starts to cough as well. Thinking that she picked something up at the medical center, Mother cancels her class to stay with Leilani. Tuesday night Leilani wakes the family three times with coughing and pain from her throat. Father suggests the emergency room at 3 am but Mother argues that it is better to wait. Getting some sleep and seeing Dr. Sia on Wednesday seems like a wiser course of action. Mother attends to her emails at 2 am: students are looking for clarification on their assignments due to the cancelled class. By 7 am, now sick with 102 degree temperature herself, Mother goes to bed. Father calls to cancel his scheduled class and makes soup for Mother and child. They both get Tylenol as well. At 1 p.m. on Wednesday afternoon Father and Leilani leave for Dr. Sia's office. They arrive at the parking structure at 1:45. By 2 p.m. they are in the waiting room. The nurse says they are early. At 2:30 Dr Sia returns from a late lunch. Leilani is called at 3 p.m. – an hour before her 4 p.m. appointment. Dr. Sia's nurse takes her temperature and blood pressure before Dr. Sia arrives at 3:15. "You have strep, young lady" he says. "Lab tests are positive. Do you have any allergies or bad reactions to any antibiotics?" Father says "No" as Dr Sia writes a prescription. Father and child leave the office for the pharmacy

on the first floor at 3:30. Behind a line of 5 at the pharmacy, their prescription is taken at 3:45. The clerk says the wait will be about 45 minutes. Father and child wait with a room full of coughing, nose-blowing, eye-rubbing people. Three babies are crying in their mother's arms. At 4 p.m. Leilani's name is called. The payment required is $52, inclusive of the co-pay. . Parking only cost $3 because the pharmacy stamped the ticket. At 4:30 Father and child set out in early rush hour to make the one hour drive home. Leilani takes the first dose of her medication at 5:31 pm. It had been 70.5 hours from first awareness of illness to the initial medication. It would be another 48 hours until Leilani is feeling alright -- a total of 118.5 hours of feeling ill. Of course, inappropriate distribution of antibiotics had been avoided. The family spent, 9.5 hours of travel and waiting time at the doctor's office. Parking cost $18. In addition to the cost of $575 per month for health insurance, a $52 payment for pharmaceuticals, and Dr Sia's bill of $73 for two visits and lab tests. The family used gasoline and clogged the road at rush hours. Mother became ill and her classes were missed for two days. Father was fine, but he too cancelled one of his classes. Healthcare was effective, but no consideration of time lost or the cascading effect of that lost time of patients and patient helpers was calculated into the systems efficiency model. All was modeled around the efficient use of the health care provider, staff and facility. This kind of care results in families who are unhappy consumers. Dr. Sia knew the parents were upset and appeared to wish that this family would find another doctor. Mother would most likely follow the same path, the next day, which Leilani had traversed. Students of Mother and Father were inconvenienced. That night, father had a sore tickle in his throat. How would this medical scenario ever change?

Let's jump ahead to 2034 when Leilani's 11 year old son comes down with a sore throat. It is 7 p.m. when Colin's temperature is registered at 103 degrees. Leilani and Dave live in a middle class neighborhood, with a modest home purchased two years earlier. The home has a standard model Arrowsmith Telehealth Center located in an alcove in the eat-in kitchen. Leilani turns on the system. The Arrowsmith interactive software immediately springs to life. Arrowsmith is an on-line interactive telehealth system functioning in millions of homes. It uses the latest artificial intelligence technologies and is capable of learning. All interactions between Arrowsmith modules and patients are, after appropriate security and privacy routine, stored in central memory; the data base is continually analyzed allowing it to contribute to Arrowsmith's learning from experience of results of diagnosis and treatments. It asks Leilani what is wrong. When she tells Arrowsmith that Colin seems ill, Arrowsmith focuses the camera in Colin's room on him and activates the measurement component in Colin's mattress, checking temperature, blood pressure and pulse probe. Arrowsmith says Colin has a 102 degree fever, high pulse rate, and normal blood pressure. Arrowsmith asks where Colin has pain. When Colin says his throat hurts, Arrowsmith requests a swab be taken by Leilani and placed within his digital and spectral analyzer. Thirty seconds later Arrowsmith confirms "Strep!" After checking Colin's stored medical records for allergies and other medications being taken, Arrowsmith automatically registers a prescription for antibiotics with the telepharmacy. . The antibiotics will arrive 3 hours later by FedEx delivery. Arrowsmith explains to Leilani that the new antibiotic capsule should arrive before 10 p.m. and she should give one to Colin tonight and one in the morning. They are so effective that Colin goes to school the following morning feeling

fine. Arrowsmith asks Leilani if she wants to be connected to a human health counselor for their further guidance. She declines and Arrowsmith signs off. At 9:45 the home delivery service arrives with the 2 pills for Colin. He sleeps well. From awareness of illness to guidance takes 5 minutes. From awareness of illness to medication takes 2 hours and 45 minutes. Colin is well within 11 hours of the initial awareness of the illness. Mother and Father are unaffected.

No physicians were visited personally; no long waits at pharmacies, nor long trips to medical centers. This tells the story of an advanced application of a subset of e-Health called "telemedicine" at work, and this is no fish story, it's the truth to be. It is a system which looks at efficiency, not just from the perspective of healthcare providers and facilities, but from a whole system point of view, avoiding many of the dysfunctional cascading effects to the lives of patients and their helpers which today's healthcare system does not take into consideration.

This book is about the pioneering of a revolution in healthcare that is stemming from the advent of information technology combined with healthcare technology... what we call e-Health.

In the pages that follow, experts from diverse fields and different parts of the globe will share their research and opinions about problems and solutions of putting e-Health, such as telemedicine, to work for society's benefit.

Telemedicine is at the forefront of clinical e-health systems. Globally, both in government and private sectors, professionals agree that telemedicine is a good idea and here to stay; most agree it is central to the future delivery of health care services. Yet, many stakeholders report that telemedicine seems more like a failure than a success. In

case after case, soon after the implementation of telemedicine, the utilization and interest curves skate downhill – sometimes to the point where the system becomes unused. While there are notable exceptions to this trend, the reported failures of telemedicine foster a reputation that distinctly challenges leaders who seek to adopt this promising technology. Further, the same dynamics relevant to the adoption of telemedicine may foreshadow adoptions of different and/or more advanced clinical e-health technology to come.

Across cultures around the world, failures are disheartening, especially for advocates of the efficacy of telemedicine and other clinical e-health solutions. To them, telemedicine clearly presents a constellation of opportunities, some of which are: to increase access to health care of the highest quality; to improve the quality of health care by providing earlier, more effective interventions; to improve the quality of healthcare by providing a mechanism for continuing clinical learning and rapid, widespread knowledge dissemination . And, intuitively, despite a recent study in *British Medical Journal* that concludes "there is no good evidence that telemedicine is a cost effective means of delivering health care." healthcare professionals and government policy planners believe that telemedicine holds the promise of decreasing the cost of health care services.

Why do so many telemedicine systems fail? What are the dynamics underlying the failure to thrive; how can we preclude such failure? Why is success so rare? What enables the successes and what can we learn from them? Research, especially the examination of the impact of organizational and individual dynamics on telemedicine, may hold the answers to these questions, not only for telemedicine but also for clinical e-health systems in general.

Normally, the root of telemedicine failure (relative to cost-effectiveness) is not the technology, but rather the human system in which the technology is implanted. When the technology is not utilized to its potential, a low number of interactions is expensed to the initial investment; the program is thus deemed too costly. Insufficient utilization is central to the failure of telemedicine: the source is neither consumer acceptance nor inadequate technology. The utilization problem is a human dynamic expressing an interesting ambiguity: healthcare providers accept the new delivery system as a good development and yet resist using it. The organizational and individual resistance may come from human-machine interface, change in organizational processes and culture, individual behavior, clinical conditions, and user preconceptions of telemedicine. Any of these dynamics within the field of human factors may stem the drop in the utilization rates to the point where cost is excessive.

This book is dedicated to understanding and resolving organizational and individual resistance to telemedicine, and prescribes specific solutions that are inordinately relevant to current challenges -- as well as to more complex clinical e-health technology of the future. The book's international comparative perspective fuels the discovery and transfer of the wisdom of diverse cultures to all others.

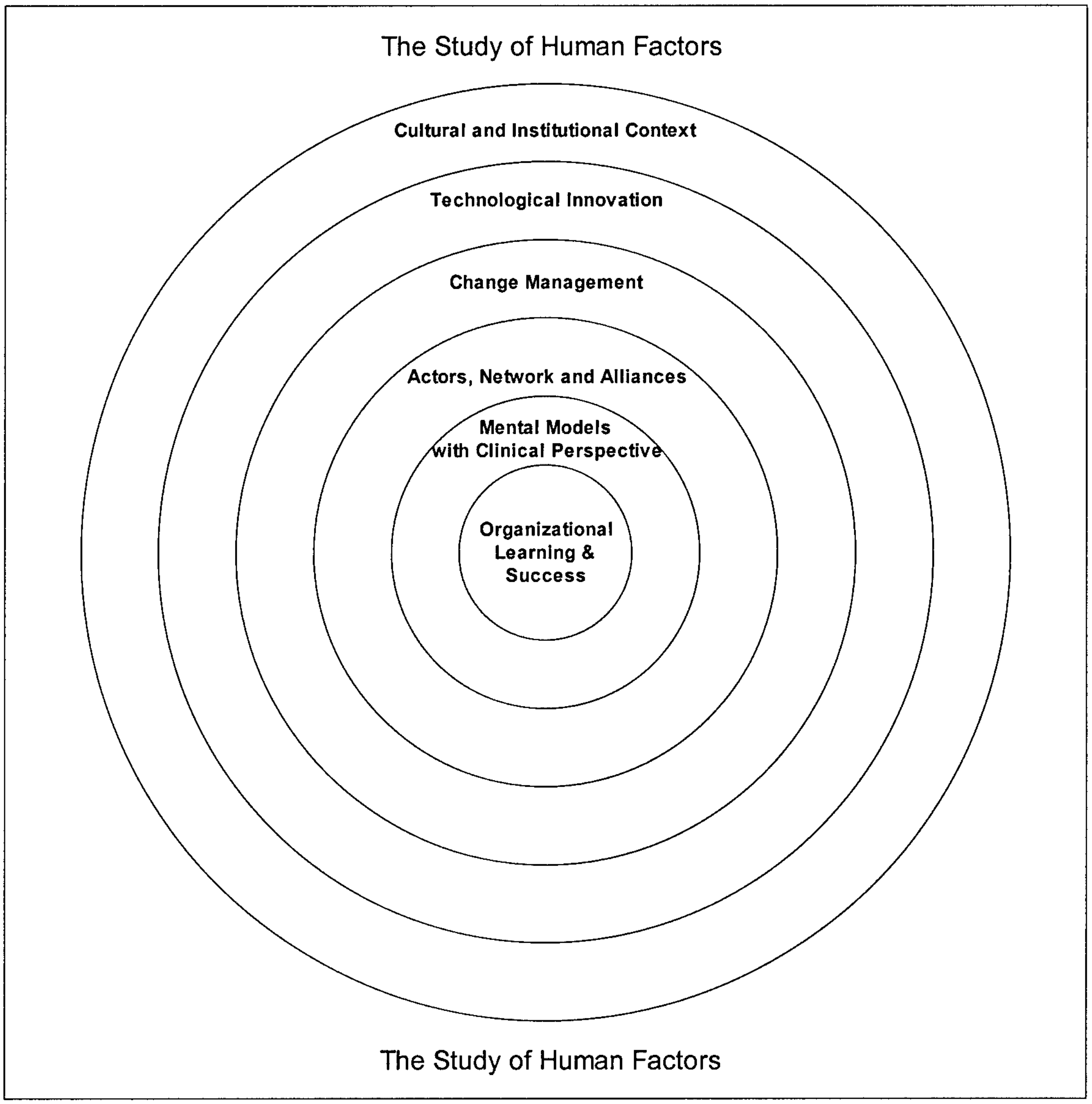
Facilitating utilization is a key to unlocking the potential of e-health technology. Understanding and managing people within an organization during a change of technology such as telemedicine is a complex, interactive and systemic challenge. Particularly since the reality of being able to isolate and control one aspect of an issue without impacting other aspects is highly unlikely. High rates of utilization of telemedicine significantly reduce the cost per consult and result in telemedicine being

viewed as a success by healthcare leaders which then allows continuation, innovation, increased access, improved quality, and reduction of the overall cost of health care. Understanding, mediating, and managing complex human factors in the adoption of clinical e-health solutions is thus essential to the evolution of global healthcare.

In this book we identify human and organizational factor issues in clinical e-health utilization. And, we acknowledge that such artificial, analytic decomposition and disintegration belies the true interconnectedness and interactivity of the health care social system.

Having made this disclaimer, we proceed to deconstruct the real world, international phenomena of acceptance/resistance to telemedicine and construct culturally competent strategies to overcome individual and organizational resistance to such e-health technology.

We conceptualize the challenge of managing successful telemedicine and e-health adoptions as peeling an onion. Revealing (understanding) each layer contributes to achieving success at the core. In this book, we peel off each layer successively, examining each before proceeding, always recognizing that these layers are constructions of our own minds; they are helpful in our understanding of nature, but are not the reality of nature. (The map is not the territory.) The reality lies in the natural symbiosis of all these aspects as coherent whole. Thus, we view the issue as depicted in Figure 1.



The design of our book seeks to present the best expert analysis of each layer of the onion in Figure 1, and to explore each layer in consideration of concurrence, sequence, and integration with each and all other layers. That is, while each expert may emphasize one layer of the onion, s/he has been encouraged to make note of its interactivity with all others. S/he may discuss it within any or all of the subfields of management and organization. Contributions from the experts may be the result of rigorous investigation, thought pieces, reviews of literature, or case studies. In addition

to these expert contributions, included in discussion of each layer are "classic" articles (found in the supplemental CD to this volume) from the broader literature on the adoption of technology and the impact of the resulting changes on the organization. Expert referrals to the "classics" are tied to the current state of e-Health and overarching principles of management and organization.

In section one of the volume, Stronge, Nichols, Rasche, Sessions, Fisk and Rogers discuss the human factors' issues (training, workload, communication, usability testing) most relevant to the challenge of facilitating the effective utilization of e-Health systems. Human factor methods (task analysis, decision-action diagrams, and questionnaires) are used to demonstrate how helpful this line of research can be in providing recommendations to improve "usability" of e-Health systems. In the next section, the viewpoint is widened.

In section two, Katzenstein/Chrispin, and Suresh/Sridhar investigate what role culture (national, organizational and/or professional) plays in the use of e-Health, and how implementation strategies may need to be "custom-designed" for different cultural environments. Here, the work of culture researchers and socio-technical systems experts are combined to help in the understanding of the necessary institutional design parameters for successful use of e-Health. Examples of "design innovation" in both African and Indian cultures enliven this section with real-world experiences in implementing an e-Health innovation.

In existing institutions, problems arise as new technologies often fit poorly with old design parameters. This is the subject of our third section of the book: putting to use new technologies, which may be disruptive to the way things have been done.

Ville/Harkke/Collan, Fulcher and Baldwin/Clarke give examples of new e-Health technologies adopted in Finland, UK and Australia. E-Health technologies of EHRs (Electronic Health Records), AIDMAN (two way, real time generalists/specialist teleconsults), and IT (information technology) in general are slow to be accepted. Understanding the causes of poor acceptance and utilization of e-Health technological innovations is thus, the primary theme of section three.

Section four focuses on application of change management techniques to aid in the problems identified in section three. Herein, we examine change management techniques applied to using new e-Health technologies. Unfreezing old attitudes and habits, changing, and then refreezing new behavior and attitudes are key ideas presented. Spil/Schuring/Michel-Verkerke/ and Forducey/ Smith/Kaur/Scheideman-Miller explore implementation approaches in the Netherlands and in Oklahoma. In both studies, early involvement of users with IT designers was seen to greatly enhance the perceived professional advantages and job relevance (unfreezing) of future e-Health users. Only after effective unfreezing of important stakeholders, do we find change successfully accomplished, and implementation a reality. To better understand the ability to unfreeze, one needs better knowledge of the characteristics of the actors, networks and alliances of the stakeholders, and so these are the topics of the next section.

In section five, Justis/Doarn/Merrell, Bomba and Seale/Robinson/Green/Walker/Berg/ Esperat/Ellison/Chalambaga investigate actors, networks, and alliances in e-Health. All these factors are necessarily considered in the design of change techniques. In this section, experiences in Sweden, Australia, and the United States point out the need to go beyond a stated positive attitude toward

implementation of e-Health, and provide both institutional and societal support for both initial and sustained usage. Networks and alliances are key ingredients in the design of such social usage support systems. Actors, too, must be supportive.

Toward this end, section six explores the mental models of key actors in the utilization paradigm of e-Health. Mackenzie/Xiao/Lam/Hu/Oglivie; Johnson/Webb/Moser/Harrigan; and Bulik/Wuff share their thoughts on the role mental models and the clinical perspective have upon implementation success and failure. It is the mental model held not just by the primary care provider, but also the mental model of the specialist and the mental model of the patient, all of which interact, and result in a greater or lesser likelihood of e-Health implementation success. This section makes it apparent that e-Health implementation success depends greatly upon the attitudes and cognition held by all involved. If primary and or specialist providers come to the table with clinical perspectives that denigrate the utility of alternative technological communication channels, and believe only face-to-face communication can be the gold standard, then implementation failure is almost always assured. If patients can achieve enhanced education and guidance so as to "upgrade" their mental models of their illness, and most importantly, understand the reasons for their treatment regimes, then the likelihood of implementation success can be enhanced. In the next section, we return to the macro-picture as we explore the mental models not of individuals, but of organizations.

Section seven is all about the shared mental models of collectivities, often called organizational culture, and how these collective models and learned and modified. Aas and Bangert/Doktor look at examples in Norway, France, UK, USA, Italy and South

Korea in an effort to understand the role organization culture and learning have upon implementation of e-Health. Users of an e-Health system generally agree that they learn while using the system. Most of the leaning of which they speak is, of course, context related to health care treatments. None-the-less, there is also, no doubt, a substantial amount of learning related to modification of their mental models of e-Health, and therefore to the shared collective mental model of e-Health, and its usability. As form follows function, it is possible that use of e-Health has the potential of causing modifications in form (organizational structures and procedures) such that the newer organizational forms will be more conducive to e-Health utilization: "Use it and you likely will not lose it." It's a circle; more conducive structures and procedures lead to even more enhanced organizational utilization of e-Health. Primary in these redesigns is the necessity to match the organization to the expectations about the organization held by key stakeholders. These expectations change with social trends. Thus, the advent of e-Health may make today a justified time to question current organizational designs in health care from the bottom-up.

The brave new world of e-Health presents immense challenges to the health care field. To date, we have only seen the tip of the iceberg. So much more is to come; and to come quickly as the Health Care Profession is at the dawn of a turbulent day, but a day filled with promise as well as challenge. It is to this promise that this book is directed.

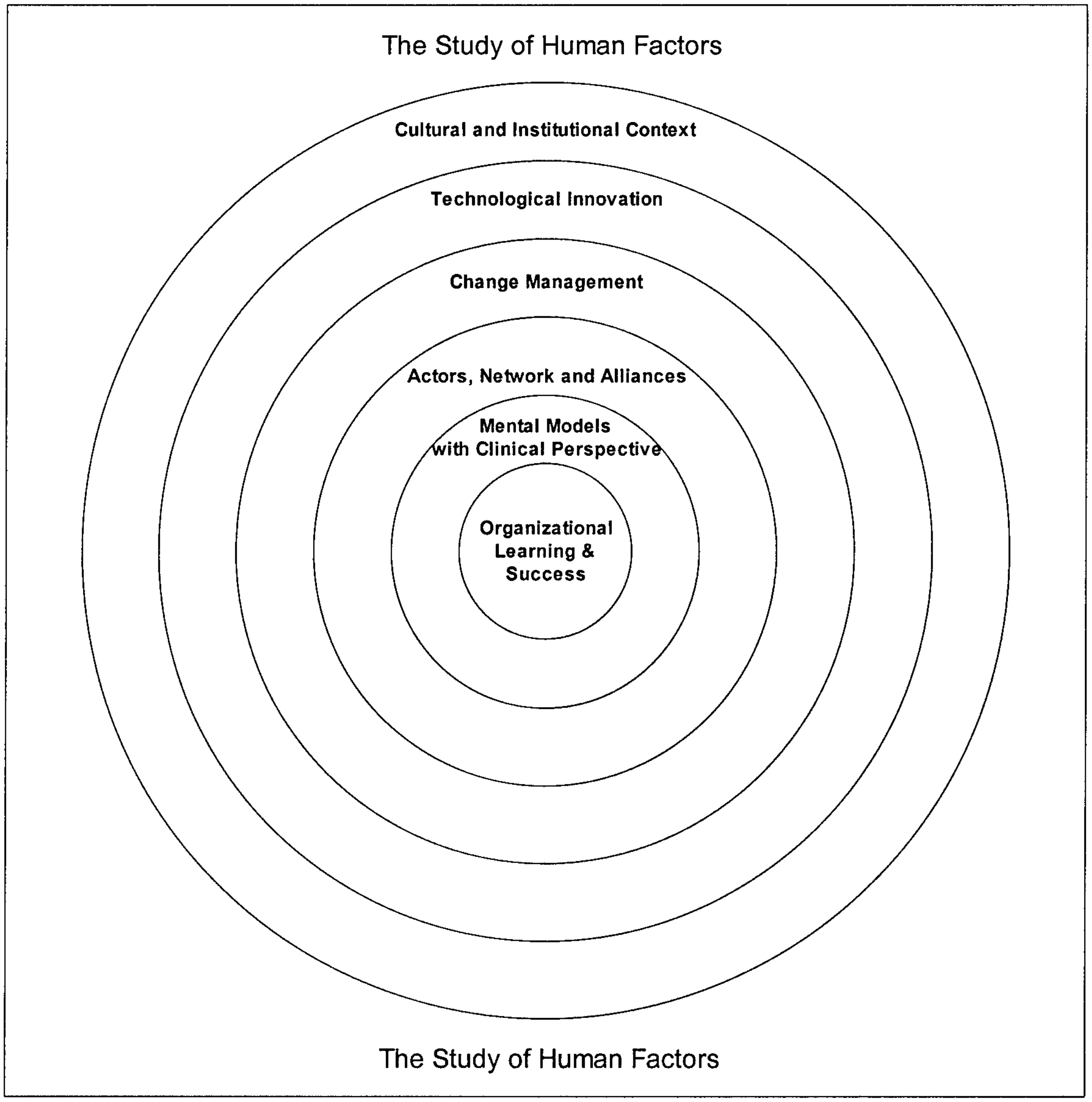


Figure in introduction, page 13

Acknowledgement

Whenever we talk about "our" book -- this tome which was seeded in a primary research effort examining telemedicine at Tripler Hospital in Hawaii eight years ago -- the ownership inherent in "our" extends to many. From conceptualization to realization, the process has been sustained by generous resources of all kinds: vision, experience, ideas, collaboration, partnership, time, language, friendship and support. Such resources cascaded abundantly in the development of this book to the editors as well as to our valued contributors. To acknowledge a few:

Our abiding appreciation first goes to those who wrote the many thoughtful, focused, fluent articles in this text. It is only through their willingness, collegiality, time commitment, and efforts to enhance state-of-the-art development of e-Health that this book could emerge. They all worked very hard, indeed. All of the contributors to this book went through a two-stage review process. First drafts were reviewed by the editors, and revisions suggested. Second drafts were all subject to internal reviews during which the contributors made suggestions to each of all the other authors in their section of the book. External reviews by subject matter experts were organized by the editors when appropriate and feasible.

Resources also abounded from our academic colleagues at the University of Hawaii's College of Business Administration (CBA) and Medical School; Thanks to CBA Interim Dean Jim Wills and his predecessor, Dean David McClain for encouraging and supporting our research of management issues in e-Health; thanks to Dean Edwin Cadman and his staff at the Medical School for supporting and facilitating our interdisciplinary studies.

With great respect, we also thank our colleagues at the US Army Medical Command, and TATRC in particular, for their willing collaboration, stalwart encouragement and for their financial commitment to providing this valuable resource to the e-Health community of practice. For going the extra mile, we appreciate the support efforts of Dr. Rufus Sessions, Col Harrison Hassell, Col Ronald Poropatish, Cheryl Merritt, and Jessica Kenyon, to name a few.

Last and not least we give thanks to our families for their understanding, comfort and allegiance during the four-years from gestation to publication of this book. . Special thanks to Leilani, Kristie and Sa'ili for understanding when Bob wasn't there; to Marianna for her encouragement and support of Michael; and to Linda for her life and career partnership with David and making his words understandable.

David Bangert
Robert Doktor
Michael Valdez
Honolulu
2004

DEDICATION

We dedicate this work to Dr. Rufus Sessions.
As an agent of change, he gave birth to the idea of this book and championed it with vigor and grace.

Dr Session's work and life made a difference to all of ours!

Section 1: Overview of Human Factors in Healthcare Technology Utilization

An Application of Human Factors Methods to Teledermatology

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The United States Department of Defense (DoD) manages the world's largest healthcare system (1) and has been instrumental in the development of healthcare innovations. During the Civil War, the first Ambulance Corps was formed to transport wounded soldiers rather than postpone treatment until a medic arrived (2). The Civil War also marked one of the first instances when military personnel used telecommunications technology to transmit healthcare information; the telegraph was used to send messages about casualties and to request medical supplies (3). Since then, various telecommunications technologies have been used in the military with the same overall goal as the first Ambulance Corps, to increase access and decrease the waiting time to healthcare treatment.

Telemedicine is the natural progression of telecommunications technology. It may be defined as the communication of health information across space and/or time through the use of technology. The DoD has launched numerous telemedicine programs ranging from teleoncology (4) to telemental health (5) as a way to practice "good medicine in bad places" (6). DoD interest in telemedicine stems from two practical reasons: to reduce disruptions in health care due to frequent changes in location, and to provide cost-effective, easily accessible healthcare to military personnel deployed internationally in small units (2). Reductions in military healthcare costs have been well documented and can be quite substantial (7; 8; 9; 5). These reduced costs include a reduction in lost work hours and travel for specialist care (7; 8; 5) as well as reduced treatment time with personnel returning to work earlier (8). However, there are costs associated with implementing and using a telemedicine system such as hardware, software, support personnel, and so on. (10). If a telemedicine system is not adopted and widely used, the financial benefits to the organization will not be realized (11).

Unfortunately, many military telemedicine systems fail to be included in the standard healthcare process. A common misconception within many organizations is that telemedicine technologies, once provided, will automatically be accepted and used (12). The field of "human factors" (also known as ergonomics or engineering psychology) is a scientific discipline that strives to optimize the relationship between technology and the human user (13). Human factors practitioners focus on increasing efficiency and minimizing error in the design, implementation, and use of a human-machine system. Bangert and Doktor's (this volume) onion model illustrated critical human factors issues in the implementation and evaluation of a telemedicine system. We have extended this

model by adding specific human factors issues within each level or "layer" (see Figure 1). For the purposes of this chapter, the levels or "layers" of this model will be discussed as they relate to macroergonomic issues, user characteristics, and technology issues. These categories are not meant to be mutually-exclusive; however, they are useful for grouping related issues.

Factors Contributing to System Success

Macroergonomic Issues

Macroergonomic issues concern organizational issues and the design of workplace systems (see 14 for a review). One macroergomic issue to consider is the cultural or institutional context in which the telemedicine technology is implemented (the first layer within the onion model). This issue is particularly salient when evaluating a telemedicine system within the U.S. military as each military branch has its own distinctive organizational culture. Moreover, some branches may be more receptive to telemedicine technologies based on their population's needs. For example, U.S. Navy personnel may be more likely to adopt a telemedicine system than other military branches due to the population's distance from specialist care. As a result of these distinct organizational climates, an evaluation of any telemedicine system must include a needs analysis. A needs analysis is conducted to define the needs of the user population and their expectations of the system (15). A telemedicine system will not be easily adopted if the user population does not perceive a need for telemedicine regardless of whether such a system could benefit the organization.

When evaluating the cultural climate within an organization, one also should consider whether the organization values learning (the sixth layer within the onion

model). A telemedicine system is more likely to succeed within an organization that incorporates educational opportunities for the development of new skills (7). An organization needs to be supportive of the telemedicine technologies and willing to devote the resources necessary to train users on the system's components.

The development of effective training programs is an essential macroergonomic issue as it leads to clinician acceptance (11; 16; 12). In a survey of a store-and-forward ophthalmic telemedicine system used by the U.S. Army, users reported difficulty viewing images because they did not know how to use the software (16). However, a training program should not be limited to training on the technology and/or software used within the system. Bangert et al. (11) assessed the training needs of military health care providers by distributing surveys to users and nonusers of telemedicine programs. Participants were asked to rank the importance of different learning objectives. Their responses were grouped according to four categories and it was found that the clinical aspects of telemedicine were considered most important for a training program (e.g., specifics about conducting a consultation), followed by the training of telemedicine technologies, organizational/management issues (e.g., funding), and the fundamentals of telemedicine (e.g., history of telemedicine).

Training also should be viewed as an opportunity to explain the organizational benefits to using telemedicine systems. Physicians within a telemedicine system may have limited mental models concerning how telemedicine can benefit them (layer five within the onion model - mental models with clinical perspective). In fact, telemedicine technologies offer benefits to both physicians and patients within the military environment. Telemedicine can increase the opportunities for physicians to

professionally interact with specialists, provide educational opportunities, and reduce the number of unnecessary patient referrals (4). For example, one telemedicine system offered physicians the opportunity to earn continuing medical education credits through online courses and hosted online conferences where physicians could meet to share information about consultations (17).

Physicians will be more receptive to a telemedicine technology if their peers endorse it (10). In particular, physicians have knowledge of the clinical issues related to telemedicine and can explain to other physicians how the system can benefit their practice (9). However, the initial acceptance of physicians must lead to continued acceptance for the success of the telemedicine system. To achieve success, the telemedicine system needs the support of a physician at each site (i.e., clinical champion) to ensure its continued use.

This clinical champion also can serve as a leader or manager to facilitate the organizational changes that need to occur as a result of the telemedicine system (layer three within the onion model - change management). For example, the clinical champion can manage how workload is distributed among the different team members. The use of a telemedicine system may increase the overall workload for physicians and their clinical staff (6) and there should be assistants in place to handle the administrative aspects of the system to reduce workload (9). Workload is also an issue at the organizational level. It is important that specialists receive recognition for the consults that they answer (7). Currently, a DoD working group has been tasked with the responsibility to complete the workload credit for a teleconsultation (Dingbaum, personal communication). Though not complete, it provides guidance on how to obtain workload credit for a teleconsultation.

However, at this time, a teleconsultation is not considered equal to a face-to-face consultation. Thus, the inclusion of an organizational support staff would be essential in managing overall workload in a military environment. The support staff should manage the number of consultations that a specialist receives to avoid overburdening them and losing their participation within the system.

The support staff also could be responsible for managing communication between team members located at different sites. Within a telemedicine system, information is transferred between users and there can be multiple streams of information (i.e., patients). The support staff needs to maintain an overall awareness of the status of information within the system. Users also need to be aware of the information within the system such as where the information originated, who should receive the information, and who to contact if they have further questions. As a result, user roles should be well-defined within a telemedicine system to optimize communication between users. In addition, the telemedicine system should provide users with feedback about their communications. In particular, users should receive feedback about which consults have been answered, which consults need to be answered, and whether there are any additional requests for information.

User Characteristics

The implementation of telemedicine technologies should be driven by the needs of its users rather than by the latest technologies (10). A telemedicine system can be designed using the latest technology, but unless there is an understanding of the user's capabilities, limitations, needs, and preferences there is no assurance of a successful human-machine system. User characteristics relevant to telemedicine center on the

concept of embracing technological innovations (layer two within the onion model). To understand the acceptance (or lack thereof) of telemedicine technologies, it is critical to consider the factors that motivate a user to begin and continue using a telemedicine system, experience and knowledge about the system and its components, any preconceived biases about telemedicine technologies, and perceived trust in the telemedicine system.

Perhaps the most important user characteristic is perceived trust in the system. Any automated system relies on user trust to ensure its use (18). In a study of a teledermatology system, the referring physicians requested face-to-face consultations because they did not feel comfortable evaluating a patient solely on the information provided via the telemedicine system (i.e., clinical history and images) (6). Thus, the quality of the digital images and the clinical history play a key role in physician trust and in turn, physician acceptance. A thorough understanding of factors that lead to trust in the system should increase the success of telemedicine technologies.

Technology Issues

There are various components within a telemedicine system including both human actors as well as non-human entities (e.g., software). A goal of telemedicine technologies is to optimize the relationship between these components (layer four within the onion model - actors, networks, and alliances). Developing standards for the hardware and software of telemedicine components would be one strategy to improve the relationship between humans and the equipment used (10). Another way to optimize this relationship would be to make the equipment more user-friendly by increasing the usability of the equipment (10). Usability can be defined as how easy an interface is to use including

how this affects learning, error recovery, and efficiency (19). The usability of a software interface in a telemedicine system is critical and it has been asserted "telemedicine application software is chosen ... with ease of use a primary consideration equal to clinical effectiveness" (9, p. 61). As a result, organizations should include usability testing as part of their evaluation of a telemedicine system (see 20 for a review of these techniques).

Furthermore, when users experience difficulty using the telemedicine system, technical assistance should be available. Technical difficulties influence the use of a telemedicine system (6) and organizations may need to include additional technical assistance to support telemedicine systems (7). Technical problems also can be related to macroergonomic issues, in particular how the organization views the telemedicine system. In the analysis of one teledermatology system used within the military, it was found that many of the technical problems associated with the system were due to additional programs added to the consult computer (9). These added programs resulted in about two calls per month in which the user reported difficulty using the telemedicine system. As a consequence of this finding, the organization enforced an agreement with the users that they would not alter the telemedicine workstation.

Human Factors and Ergonomics Methods

Human factors and ergonomics methods can be used to evaluate telemedicine systems and identify the issues that contribute to their success. The field of human factors utilizes various assessment methods to understand the capabilities and limitations of people to design "systems, organizations, jobs, machines, tools, and consumer products for safe, efficient, and comfortable human use" (21, p. 4). As discussed in the

previous section, the human factors issues related to the success of telemedicine systems fall under the general categories of macroergonomic issues, user characteristics, and technology issues. However, human factors and ergonomics methods can also identify potential errors and problems, propose suggestions for how to fix those errors and problems (i.e., it can be prescriptive), and provide guidance in the development of new system and predict where errors and problems may occur.

The human factors and ergonomics techniques used to collect data about macroergonomic issues, user characteristics, and technology issues include task analysis, decision-action diagrams, and tools to elicit information from system users such as questionnaires, structured interviews, and focus groups (see 22 for a review of these methods). Although it is not required, it is recommended that there should be a progression from the task analysis and decision-action diagrams to the tools targeted at system users as each method can build off the previous one.

Task analysis is the detailed description about the work activities of the people who are involved with the specific system (see 23 for a review). A task analysis consists of a listing of activities and behaviors that are required to complete a given task including the hardware involved in the task (e.g., telemedicine equipment) and performance requirements (e.g., turn-around time for a consultation). Each task is divided into the subtasks required to carry out the task and each subtask can be analyzed on factors such as the feedback information the user receives from the system and potential sources of error.

To aid in the conceptualization of the system tasks, decision-action diagrams are often developed. Decision-action diagrams are defined as "a procedure for decomposing

or identifying the sequence of functions or actions that must be performed by a system" (24, p. 93). Decision-action diagrams represent the flow of information in the system and can be useful in identifying communication issues, how workload is distributed among team members, and where problems or errors could cause a breakdown in the flow of information. Although task analyses and decision-action diagrams are useful for understanding individual tasks and how to optimize their performance, they are not a substitute for the knowledge that can be gained through interactions with actual users of the system. However, they can provide guidance in the development of questionnaires, structured interviews, and focus groups to assess users' knowledge, beliefs, and opinions about the system.

A questionnaire approach facilitates the collection of information from a large number of users in an efficient manner. If the sample is large enough, questionnaires can be useful for collecting quantitative data (e.g., how many times a problem is encountered or how frequently a particular error occurs). However, questionnaires provide only limited data that is qualitative in nature (e.g., what is the nature of the error being made, what is the context under which communication difficulties arise). The goal of structured interviews and focus groups is to gather rich qualitative information from participants such as their beliefs, opinions and experiences interacting with a telemedicine system (25).

A structured interview is a questionnaire administered in-person with the opportunity to ask follow-up questions. In general, data collection and data analysis for structured interviews is more time-intensive than for questionnaires because only one person is interviewed at a time and the data are qualitative and must be coded. Focus

groups involve the administration of the questionnaire in a group setting; as a result they may be less structured in nature than structured interviews, but they are also useful for collecting qualitative data to assess users' beliefs and opinions about telemedicine. During a focus group, a moderator engages a group of system users about a given topic giving them the opportunity to follow-up on various comments. Similar to structured interviews, the analysis of the qualitative data can be time-intensive although data collection itself is less time-intensive as multiple participants are interviewed at the same time. However, within the group situation it is important to employ an experienced moderator as some participants may be overly influenced by others within the group (26).

The Current System Evaluation

Telemedicine systems vary in their clinical applications (e.g., teleoncology, telepsychiatry), the type of information transferred (e.g., video, audio, text), and whether the communication is synchronous (i.e., real time) versus asynchronous (i.e., store-and-forward) (27). Synchronous telemedicine systems typically employ video-conferencing technologies to enable real-time patient-doctor communications that are similar to a face-to-face consultation (28). However, there are limitations to synchronous communication in that it requires a large amount of bandwidth and all parties must be present at the same time which can be a challenge when time zones differ at each location (28).

In store-and-forward telemedicine systems, patients' medical histories and digital photographs of their condition are transmitted to a healthcare provider (29) and reviewed by that healthcare provider at a later time (28). In contrast to synchronous telemedicine, store-and-forward systems typically requires equipment that is less expensive, lower

bandwidth, and members of a team do not all need to be available at the same time (6). The Internet is particularly useful as the medium to relay information between team members because it is cost-effective while still maintaining an ability to transmit sizeable amounts of information (6). However, there are also limitations to store-and-forward telemedicine systems because if the patient's history is deficient, incorrect, or image quality is poor, the specialist cannot ask immediate follow-up questions concerning the patient's condition (unlike real-time video conferencing) (6). Moreover, long download times for digital images may be frustrating to users. Despite these limitations, store-and-forward systems are potentially very useful, especially in areas such as dermatology where the number of specialists is limited and high quality images can be transmitted via the Internet. For these reasons, the use of store-and-forward technologies will most likely be the future of teledermatology (29).

The current system evaluation focused on an asynchronous teledermatology system that is currently used by the U.S. military. There is a need for teledermatology systems within the military as dermatologic conditions in the armed forces are a common cause of death and loss of work days (30). Teledermatology is defined as the "interpretation of electronically transmitted images and clinical history to reach a diagnosis and provide recommendations for therapy" (6, p. 113). Teledermatology is particularly amenable to the goals of telemedicine because a picture of the condition is easily transferred via the Internet and the dermatologist can make a recommendation based on the picture. Much work in the field of teledermatology has been directed towards the development of software that can compress a large digital image file without losing too much of the image's resolution (29). These efforts appear to have been fruitful

as the general finding in the literature is that dermatologists can be as diagnostically accurate and reliable using store-and-forward telemedicine technologies as they are in face-to-face consultations (29). For example, one study that compared the level of agreement between teledermatologists and dermatologists who met with patients face-to-face found a 77% agreement between the two groups (31).

There are four user groups in the teledermatology system we evaluated: (1) primary care managers (i.e., general physicians), (2) consult managers who assist the primary care managers in interactions with the teledermatology system (not all sites have a consult manager), (3) dermatologists, and (4) technical support personnel consisting of a nurse coordinator and a system administrator. The system was evaluated using the following human factors methods: task analysis, decision-action diagrams, and a questionnaire targeted at subject matter experts.

Task Analysis

A task analysis begins with identification of the high-level tasks involved in using the system. We used multiple methods to acquire information for task analysis of the teledermatology including discussions with the support staff, analysis of the teledermatology website, evaluation of the training materials, and review of the internal documentation managed by the nurse coordinator. The overall teledermatology system consists of four high-level tasks: (1) a patient with a dermatological condition visits a primary care manager, (2) the primary care manager (and/or consult manager) processes the patient and completes the online consult form on the teledermatology website, (3) the dermatologist reviews the consult and provides recommendations for patient care, and (4) the primary care manager receives the recommendations and applies them to the patient.

Additionally, the support staff ensures that the consult is approved and responded to in a timely fashion, monitors the communication between the primary care manager and dermatologist, and oversees the quality of the consults.

The system may appear relatively simple and straightforward based on the identification of the high-level tasks. However, one of the goals of a task analysis is to identify all of the subtasks (i.e., steps) required to complete a given task. The first high-level task within this system is when the primary care manager and/or consult manager processes the patient. A task analysis revealed that this task involved a total of 91 possible subtasks (see Table 1 for subsections from the task analysis). Each subtask was listed in order and the following factors were considered: the feedback the user received from the system, the potential errors that could occur, and how system efficiency could be improved through design.

An example of a feedback issue is when the primary care manager uploads the pictures of the patient's condition onto the teledermatology website (see Table 1, step 4.4.6.3). The system provides the user with feedback for which pictures have been uploaded. However, the feedback that the user receives from this subtask is insufficient because the system assigns a unique file name to each picture that is different from the name that the user assigned the file. As a result of this feedback, a user could attach pictures from another patient resulting in a misdiagnosis of the current patient's condition.

An example of a potential error is when the user submits an image onto the website (see Table 1, step 4.4.6.2). If the user hits the back button, it appears that the

image has disappeared, and if the user tries to re-submit the image, the entire consult may be lost.

An example of how to improve system efficiency through design has to do with filling out the required information on the online consult form (see Table 1, steps 4.4.2.4-4.4.2.5). On one screen of the consult form, most of the required fields were grouped together except for two required fields that were off to the side and easy to miss. A design recommendation for this potential problem would be that for any required fields, designers should use appropriate grouping cues so that important information is entered.

These examples illustrate the importance of analyzing each subtask involved in a particular task to understand where users might encounter difficulties and to make recommendations for design improvements and perhaps training as well. We have provided only a small set of the subtasks analyzed in the complete analysis. These factors were considered for every subtask that needed to be completed within the system (32).

Decision-action Diagrams

Based on the task analyses, decision-action diagrams for each person involved in the system were developed including a decision-action diagram for the overall system. Figure 2 is an example of a decision-action diagram for one team member, the dermatologist. The dermatologist logs into the teledermatology website, selects the appropriate consult, reviews the consult, and provides recommendations for patient care. One potential breakdown in the flow of information due to a communication issue could occur if there is additional information required. At this point, the dermatologist should contact the primary care manager and request more information. If the primary care

manager sends the amendments or additional information through email, this could be a potentially confusing situation because the email will not be tied to the original consult and the dermatologist may have difficulty remembering which consult it refers to. The task analysis and decision-action diagrams serve many purposes, one of which is to identify sources of user difficulties at different levels ranging from the specific design of the interface to inter-individual communication within an organization.

User Questionnaires

Task analyses and decision-action diagrams also provide guidance for the development of questionnaires to understand the critical human factors issues that involve macroergonomic issues, user characteristics, and technology issues. We designed a questionnaire to assess the human factors issues already identified as well as questions about issues that could not be identified through the task analysis and decision-action diagrams (e.g., the specific context in which errors might occur or the degree to which training was successful). The questionnaire consisted of multiple-choice, rank-order, and open-ended questions (see Appendix A for example questions of macroergonomic issues, user characteristics, and technology issues).

Five subject matter experts (i.e., experienced users of the system) were queried: two primary care managers, two dermatologists, and one consult manager. A questionnaire was used for this sample as opposed to a structured interview because we wanted the subject matter experts to critically evaluate the questions we were asking and the form in which we were asking them (this study was a pre-cursor to a structured interview study conducted with a larger sample of participants) (33). A written questionnaire was used to enable the subject matter experts to evaluate the wording of the

questions and to provide guidance about the structural organization of the questionnaire. All five subject matter experts were male and reported a range of experience with the system from less than six months to less than five years. Responses to the questionnaire were categorized according to the human factors issues that they referenced and example responses have been included in the following sections to illustrate the type of data that can be gathered through questionnaires.

Macroergonomic issues. We identified four macroergonomic issues: workload, communication, training, and the involvement of the support staff. Concerning workload, one dermatologist reported that high workload resulted in his inability to "complete all consults on a given day." Another dermatologist reported that it was "difficult to capture the workload involved with the system because they do not get credit in the military for a patient visit for each consult that is answered." However, they reported that "training nursing staff to send the consults to the physicians" would help to reduce this workload.

Communication issues can arise when the primary care manager contacts the consult manager through the system. In the current system, different dermatologists are assigned to work on different days. One primary care manager reported that he sent out a request for more information, the request arrived at a different time, and it was not returned to the specific dermatologist. This disrupts communication between the primary care manager and the dermatologist and creates a potentially confusing situation. Primary care managers also reported that they needed to contact the support staff regarding confusion about a dermatologist's recommendations, about errors in the consult, operational issues regarding the website, and insufficient information in a

consult. These data speak to the need for having support staff accessible to system users to oversee communication within the system.

None of the users reported difficulty in learning to use the system suggesting that the training for this teledermatology system was sufficient in meeting the needs of its users. This may have been the result of the type of training they received. Most of the users received one-on-one training from the support staff that oversees the system. One subject matter expert reported that potential users should be educated about telemedicine's benefits to "market service to patients and primary care managers as a useful consultative tool." Thus, as discussed within the onion model, training programs should not be limited to telemedicine technologies, but should include the benefits of telemedicine technologies.

The support staff responsible for overseeing the entire consult process was reported to be an integral part of this telemedicine system. Users reported that the support staff members were "very supportive and dedicated," "wonderful, intelligent, and patient," "easy to get a hold of," and "eager to help." The support staff was responsible for facilitating the adoption and continued use of this telemedicine system. However, these comments indicate the potential importance of individual personalities for the overall success of the system.

User characteristics. Motivation to learn and continue using a telemedicine system may contribute to users' willingness to embrace a telemedicine technology. The subject matter experts were asked to rank order the importance of certain factors in motivating them to begin using the system and continue using the system (see Appendix A - user characteristics). The majority indicated that they began using the system and

continued using the system because it was a useful professional experience. They reported that the telemedicine technologies enhanced their professional experience through "rewarding exposure to technology/telemedicine with excellent real world applications," "helped with feedback, don't usually get feedback from regular consults," and "one on one conversation with specialist talking to them via consult and pictures helps to demonstrate my thinking."

Technology issues. Technology issues include the usability of the teledermatology website and any technical failures associated with the technology used. One usability issue that emerged was the function of the back button when filling out an online consult form in that "clicking it will cause loss of comments in the narrative section." Other technical issues included difficulty accessing the server, trouble filling out the online forms, and incorrect email addresses. Although these technical issues are specific to the current system, they can be generalized to provide guidance to designers of future telemedicine systems. For example, telemedicine systems should have online forms that are usable by people with a wide variety of technology experience and they should be designed to guard against loss of information. One strategy would be to give users the option to save information on a page before moving to the next page. Another strategy would be to avoid the need for navigational buttons by designing the online consult form to present the information on a single page that allows the user to scroll down the form. Identifying the technology problems with a system enables designers to improve users' interactions with the system.

Discussion

The U.S. military has established various telemedicine programs. Although the advantages of these programs have been identified, not all telemedicine programs in the military have been adopted and widely used. Human factors methods can be used to evaluate a telemedicine system by emphasizing factors critical to system success. In the present analysis, task analysis, decision-action diagrams, and questionnaires operated in conjunction to identify macroergonomic issues, user characteristics, and technology issues. Each method provided unique information about how these factors contribute to system success. The task analysis provided detailed information about the tasks involved in using the system including a focus on the feedback the user received from the system, the potential errors that could occur, and how to improve system efficiency through design. The decision-action diagrams were useful in illustrating the flow of information through the system by demonstrating how workload and communication issues might cause a breakdown in the system. Finally, the questionnaire was a valuable method to obtain information from subject matter experts about specific user issues including the factors that motivated them to begin and continue using this teledermatology system.

Standard techniques of human factors analysis were used to identify overall human factors issues involved in the implementation and adoption of telemedicine technologies. The issues of most relevance could be incorporated as part of Bangert and Doktor's (this volume) onion model, as illustrated in Figure 1. Future research efforts should be directed towards increasing our understanding of the specific issues involved within the different levels of the onion model.

Within the area of telemedicine, one challenge faced by human factors specialists is to develop "methods and tools for assessing potential users' needs and for matching

characteristics of particular telemedicine technologies to these needs" (10, p. 79). The methods discussed in the evaluation of the current teledermatology system could serve as a toolkit for evaluations of other telemedicine systems. This toolkit can be used as the basis for the development of an objective assessment tool to aid in the evaluation of human factors issues that can be used with other existing telemedicine systems (i.e., prescriptive) and in the development of future telemedicine systems (i.e., predictive).

Based on our review of telemedicine systems used within the military and our analysis of a teledermatology system, we propose the following recommendations for the successful implementation of a telemedicine system used within the U.S. military. We have grouped these issues into the categories of macroergonomic issues, user characteristics, and technology issues.

Macroergonomic Issues

- To ensure the successful implementation of a telemedicine system, organizations should value learning, the development of new skills, and emphasize the benefits of using the telemedicine system.
- The development of training programs should include the clinical aspects of telemedicine, training of telemedicine technologies, organizational/management issues, the fundamentals of telemedicine, and the organizational benefits of telemedicine systems.
- An enthusiastic support staff and a clinical champion should be recruited to assist with training, oversee communication, and monitor the quality of the consults.

- At each referring site, assistants should be included to reduce the administrative workload of physicians.
- Ideally, physicians should receive workload credit for the consults that they answer. However, as this is presently not the case, a support staff should manage workload to ensure that physicians are not overly burdened.
- Communication should be optimized to increase users' awareness of the information transferred within the system.
- Roles within the telemedicine system should be well-defined.
- System feedback should be included in the design of any telemedicine system. This feedback information should indicate what consults have been answered, what consults still need to be answered, and so on.
- There must be flexibility within a telemedicine system to support communication between users and a support staff to manage communications within the system.

User Characteristics

- An understanding of the users' capabilities, limitations, needs, and preferences should drive system design.
- Improving the quality of the digital images and ensuring that the patient's clinical history is complete can increase perceived trust in a telemedicine system.
- Increase users' motivation to begin using and continue using telemedicine technologies by informing them of how this experience will enhance their professional experience.

Technology Issues

- Technology used within a telemedicine system should be user-friendly; that is, usability analysis should be conducted on all the components of the system to ensure that a variety of users can operate the technology, that the appropriate feedback is provided to the users, that errors are minimized, and that error-recovery is supported.
- Usability evaluations should be conducted on both the hardware and software applications used within a telemedicine system.
- Technical assistance and support should be available when users experience technical difficulties within the system.
- Online forms should be designed to be usable by people with a range of technical backgrounds and be structured to guard against loss of information.

Conclusion

In sum, the purpose of the present chapter was to demonstrate how human factors methods can be used to identify macroergonomic issues, user characteristics, and technology issues that are most relevant to the design and successful use of a telemedicine system. More specifically, these methods are critical in drawing attention to where errors and problems can occur within the system and ultimately, lead to the failure of a telemedicine system being successfully adopted and widely used. The results from these methods can be used to provide guidance for the present system as well as in the analysis of other systems and for the development of future systems.

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Appendix A

Questionnaire distributed to experienced users of the teledermatology system (selected questions).

Macro-organizational – Workload

1) For each of the following teledermatology system tasks, indicate on a scale from "Never" to "Always," how often you were the person who performed each task (e.g., even if a task occurred once a month, but you were the person who always performed that task, you would check "5").

	← Never Performed / Always Performed →				
	1	2	3	4	5
Online (web) tasks:					
Complete online consult form					
Review online consult form for errors					
Submit online consult form					
Consult-related communication (e-mail) tasks:					
Correspond with dermatologists					
Correspond with the CTA: Nik and/or Angela					
Correspond with your clinic support staff					
Patient interaction tasks:					
Complete a written consult form					
Obtain written consent from the patient					
Take digital images of the patient					
Organizational tasks:					
Communicate with system administrator (i.e., Nik) in the event of technical issues with computer and/or digital camera					
Ensure timely progress of online consult and feedback					
Keep a record of digital images, forms, etc.					
Provide system training/assistance to other staff					
Other (please describe):					

____

____

User characteristics – Motivation to continue using the system

1) What encouraged you to continue to use the teledermatology system? **For those that are relevant, numerically order by importance, with "1" indicating most important.**
   Encouragement from chain of command / upper management
   High patient satisfaction
   High personal satisfaction
   System provided a faster consultation process
   System was easy to use (relative to standard referral procedure)
   Useful professional experience
   Other (please describe): ______________________________

____

Technology issues

1) Indicate if you have ever experienced these problems with the system. Check the appropriate box to indicate the frequency with which these problems occurred (check "0" if you have never experienced this problem). Please briefly explain the problem.

	← Less Frequent / More Frequent →					
	0	1	2	3	4	5
Hardware problems						
Explain: ______________________________						
Losing information entered into online consult						
Explain: ______________________________						
Navigation of consult website						
Explain: ______________________________						
Online communication with others w/in the system						
Explain: ______________________________						
Other (please describe below)						
Describe: ______________________________						

____

AUTHOR NOTE

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Table 1

Sub-sections of the Task Analysis of the High-level Step "Primary Care Manager/Consult Manager Processes the Patient

Step	Description	Feedback	Potential errors	Design issues
4.4.2.4	Enter unit	User is required to respond before proceeding to the next screen.	Organization of fields is confusing. Easy to miss unit and rank.	For any required fields, designers should use appropriate grouping cues.
4.4.2.5	Enter rank	User is required to respond before proceeding to the next screen.		
4.4.6.2	Repeat steps 4.4.6.1.1.3 as necessary for up to 5 images	When an image is submitted and the user presses a back button, there is no feedback.	Entire consult is lost, as system will not continue to process the consult.	Users should receive feedback that the original picture has been submitted.
4.4.6.3	Click next button	User is given feedback that images have been uploaded. Each image is given a unique file name by the system. There is insufficient feedback about what pictures have been attached.	User may attach the wrong pictures at this point and not realize it.	1. Inserting a thumbnail of each picture would help users see what they have attached. It would also help to have a filename next to the pictures. 2. The button on the menu bar should not be called cancel/main menu. It should be called Cancel this Consult – then on the very last page of the consult, it should be called return to main menu. In particular, on this page it should not be called the cancel/main menu button because you cannot cancel the consult at this point - it has already been created.

Figure 1. *An* extension of Bangert and Doktor's (this volume) onion model to incorporate human factors issues.

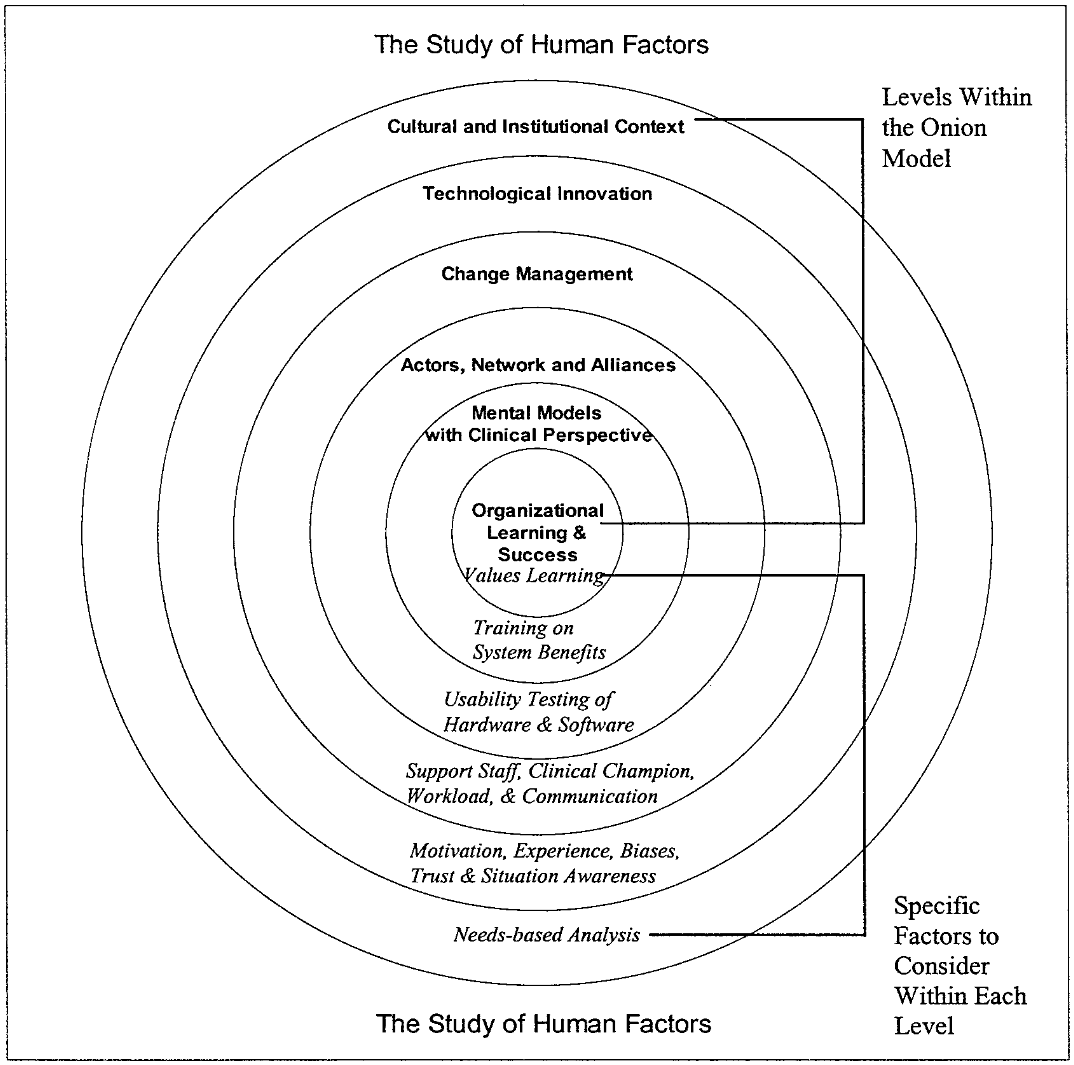
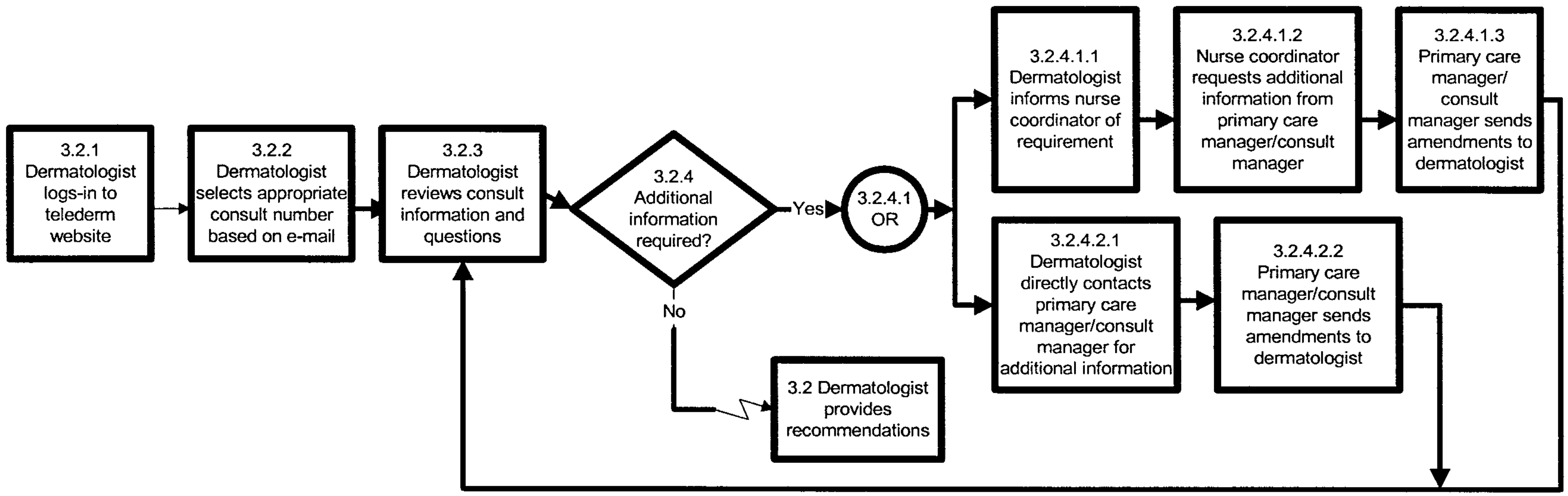


Figure 2. Decision-action diagram representing the activities of the dermatologist.



or software developers, finding replacement parts or qualified technicians, or even identifying software codes that need to be changed, may be difficult and expensive. The crises facing the nation's huge but obsolete air traffic control system dramatize this problem (Frey, 1996). Equally dramatic is the "millennium" or "year 2000" problem facing many banks and other major institutions that still rely in mundane but critical ways upon old, often undocumented software that cannot easily be changed to handle dates past the year 1999 (Duvall, 1996; IBM, 1996).

HUMAN FACTORS AND THE ACCEPTANCE OF TELEMEDICINE[2]

The human infrastructure of telemedicine—like the technical infrastructure—is varied and complex. It generally will include an *intra*organizational and an *inter*organizational mix of clinicians (e.g., physicians and nurses), clinical support personnel (e.g., radiology technologists), physicists, engineering and computer specialists, administrative support personnel (e.g., appointment schedulers), and managers at consulting, satellite, or other sites. In addition, those directly involved in telemedicine will ordinarily be linked to other personnel involved in financial administration, information systems management, research, and a myriad of patient care activities.

Getting these human components—both individuals and organizations—to work well together and with complex and changing technologies is a never-ending challenge. By illuminating when and why these components are not performing as intended, evaluators can help program managers decide whether to continue, discontinue, or redesign operations and can also suggest to vendors and designers how their technologies might be better designed to accommodate human characteristics.

A major frustration with modern technologies is that while they promise to make life easier for people, they may simultaneously make it more difficult. Human factors engineer Donald Norman emphasized this in his book *The Design of Everyday Things:*

> We are surrounded by large numbers of manufactured items, most intended to make our lives easier and more pleasant. In the office we have

[2]This section is based on a background paper drafted by John C. Scott and Neal I. Neuberger.

> computers, copying machines, telephone systems, voice mail, and fax machines. . . . All these wonderful devices are supposed to help us save time and produce faster, superior results. But wait a minute—if these new devices are so wonderful, why do we need special dedicated staff members to make them work—"power users" or "key operators"? Why do we need manuals or special instructions to use the typical business telephone? Why do so many features go unused? And why do these devices add to the stresses of life rather than reduce them? [Norman, 1990, p. vii]

The task of answering these questions (and seeing that they are asked) falls particularly within the domain of human factors engineering. This discipline seeks to design equipment, systems, and jobs by applying knowledge about how people interact with machines and how preferences and abilities affect these interactions (see, e.g., Salvendy, 1987; Rouse, 1991; Dumas and Redish, 1994; Gosbee, 1995). The issues raised and the strategies proposed by human factors engineers can inform designers and evaluators of telemedicine projects.

Growing Recognition of Human Factors

A recent overview of telemedicine technologies by two experienced telemedicine researchers argued that "most failures of telemedicine programs are associated with the human aspects of implementing telemedicine" (Allen and Perednia, 1996, p. 22). Similarly, in its site visits, meetings, and other activities, the committee heard repeatedly about the human factors that appear to underlie the rejection or limited acceptance of telecommunications and information technologies by otherwise interested clinicians and administrators.

Policymakers, too, have begun to appreciate that many of the programs which they have funded have used telemedicine far less than originally anticipated. For example, the federal Office of Rural Health Policy (ORHP), the Health Information and Applications Working Group of the Information Infrastructure Task Force Committee on Applications, the National Library of Medicine, and other agencies have sponsored a number of workshops and conferences on the opportunities and barriers facing telemedicine (see, for example, ORHP, 1993a; Bashshur et al., 1994, 1995; CPSC, 1995; Scott and Neuberger, 1996). Participants in these conferences have concluded, first, that much more research is needed to determine how patients

and health professionals respond to telemedicine and, second, that the starting point for telemedicine should be the identification of needs and preferences of consumers and providers from a user- (e.g., patient, practitioner, community) rather than a technology-driven perspective. They also identified factors that may slow acceptance and adoption of telemedicine, including lack of documented benefit for clinicians; difficulty of incorporating telemedicine into existing practice; problems related to equipment; concerns about professional image; inadequate assessment of needs and preferences; lack of societal readiness; and health care restructuring (Scott and Neuberger, 1996). *rotation of staff*

To incorporate an examination of human factors, evaluators may in some cases be able to use program logs, debriefing interviews, or questionnaires to detect how these factors may have shaped the effects of telemedicine application. In other cases, they may infer the existence of certain problems based on their own experience, for example, their own frustrations with the technical limitations of hardware and software used in a particular application.

Although the research literature documenting the conditions for successful telemedicine programs is sparse, the conclusions above reflect a common view that telemedicine's successful transition from the demonstration phase into one of wide-spread use depends on better approaches to the human factors in telemedicine. The discussion below, which draws on the sources cited above, considers two broad categories of such factors: practical and socioeconomic. Users and potential users may also be discouraged by real or perceived policy barriers to telemedicine. Chapter 4 examines a number of such policies, including those that exclude payment for most consultations that are not provided on a face-to-face basis.

where is clinical ok?

Practical Human Factors

Problems Related to Equipment

Telemedicine and information technologies are frequently "user unfriendly." Vendor sales, support, and other practices may also be frustrating and constraining. Among the problems reported to the committee were

- problems with the convenience, reliability, quality and integrity of equipment;
- lack of time to learn the correct use of complicated hardware or software that requires extensive training and continued reference to lengthy and highly technical user manuals;
- equipment purchase decisions based on grant and other financing requirements rather than appropriateness;
- lack of flexibility with proprietary systems;
- vendor restrictions on equipment leasing, which dictate large capital investment and maintenance costs for purchased equipment;
- constantly changing sales representatives and vendor product lines; and
- lack of market influence by small purchasers over vendors.

These problems are compounded when vendor marketing practices heighten clinicians' expectations about equipment performance and ease of use and then cannot deliver on their promises. Further, most product specifications and proposed technology solutions reflect the perspective of the technology vendor rather than the user of the product. More attention to applications-driven design, human factors engineering principles, and business process re-engineering might help to alleviate many of the problems identified here.

Difficulty of Incorporating Telemedicine into Existing Practice

When awkward, early stage telemedicine technologies and procedures are grafted piecemeal onto existing routines, the result can be important time management problems for clinicians and their patients. For example, interactive applications may require that primary care and consulting practitioners in different locations abide by the same schedule in order to use "real time" telemedicine systems. When managers in one telemedicine program charted the steps to schedule a telemedicine consult, they found it took at least 5 calls to do so and could take up to 25 calls (Armstrong, 1995). In contrast, much consultative medicine is practiced "asynchronously" with attending and consulting clinicians leaving messages for each other throughout the course of the day or over a period of days. Patients rather than data are often responsible for moving from place to place in the standard consultative medicine scenario. Computer-based scheduling programs can reduce though not eliminate scheduling

Box 3.1
Human Factors, Telemedicine, and the Telephone Analogy

In several respects, the current status of many telemedicine systems mirrors that of early telephone systems (Sanders, 1995). Earlier in this century, apartment buildings with 20 to 30 individual apartments typically had only one wall telephone on the ground floor for the entire apartment complex. When the phone rang, the hope was that a tenant in a nearby apartment would answer it and call to the phone the person being sought. This was inconvenient for all involved. Networking was inefficient and switching systems were slow; a person first had to reach an operator who in turn made a manual connection to another line. In addition, the sound quality was poor, maintenance was a problem, costs were high, and lines and equipment were scarce. Not surprisingly, telephone use was infrequent. The telephone only became indispensable when the communication infrastructure allowed for multiple, private lines in an apartment complex, so that each family had its own private line and could directly dial the party wanted.

problems, but the adoption of common or compatible systems across different organizations is not necessarily a simple step.

Another problem is the physical location of the telemedicine units, which are not always located where the services are being provided (e.g., a physician's office). In some cases, such an arrangement may seem reasonable, akin to having physicians go to the emergency room to see patients in urgent and emergency situations or having radiologists use special viewing rooms. More often, such an arrangement is artificial and inconvenient. Even if the equipment is only five or ten minutes away on another floor or in a nearby building, this can serve as a powerful deterrent to frequent use. Box 3.1 suggests parallels between the current status of tele-medicine systems and early telephone systems.

The widespread availability of practical and affordable desktop work stations should make it easier to employ telemedicine and a variety of other applications, such as patient record, clinical information, and decision support systems. Whether telemedicine or other applications are cost-effective for any specific user and situation still, however, would need to be assessed.

E-mail, voice mail, and fax machines—tools that are often overlooked as telemedicine technologies—may be better suited to some routine clinical communications, although improved store-and-forward technologies for data transmission should also permit for easier off-line consideration of information in response to medical requests.

In the future, clinicians could have available in one multimedia work station the capabilities, if needed, for visual (e.g., still images, full-motion video) and audio communication, graphics, medical literature searches, diagnostic peripherals, electronic mail, fax, and telephone. This technological base appears to be developing, pushed in considerable part by other service-oriented industries (e.g., entertainment, shopping, banking). The cost-effectiveness of telemedicine work stations, however, needs to be assessed, not assumed, for any given setting and set of uses.

A further issue involves the timely availability of relevant patient information. Clinicians involved in telemedicine consultations and other services often lack the whole picture, including patient history as well as current status and condition. Many health care institutions and most clinicians have not yet adopted computer-based patient records systems, but even those who have done so may find it difficult to integrate them with telemedicine applications. Barriers include the lack of common definitions and clinical vocabulary, inadequate standards for sharing and protecting the confidentiality of electronic data, and inconvenient documentation and data retrieval procedures. (In late 1996, the IOM plans to republish its 1991 report on the computer-based patient record with new commentaries describing developments since the original report was issued.)

Inadequate Assessment of Needs and Preferences

Given the discussion above, it is not surprising that a common criticism of advanced technologies is that developers and promoters too often fail to ask what practical needs or problems the technology might address. Even if such questions are asked, however, one dilemma in needs assessment is that "end users [in many instances] do not quite know what they want" and cannot readily imagine the uses of complex technologies with which they are often unfamiliar (NRC, 1996, p. 32). Thus, statements of provider or community needs may read like wish lists rather than realistic assessments and statements of priorities.

Needs assessments have several components. One involves the health status, problems, and other characteristics of the relevant population. A second relates to the characteristics, capacities, and objectives of individual practitioners and health care organizations. A third involves more broadly the characteristics and capacities of

the health care system, including insurance coverage. User preferences may also be considered. For example, if color is preferred to black and white video, user aesthetic preferences may be relevant to decisionmakers considering video options. Even if a strategy may fail without such accommodation, financial considerations will undoubtedly affect the extent to which decisionmakers are willing to accommodate user preferences.

One pressing challenge is to develop methods and tools for assessing potential users' needs and for matching characteristics of particular telemedicine technologies to these needs. One study that attempted to determine clinicians' information needs employed a multidisciplinary evaluation team that (1) directly observed a randomized sample of clinicians for an eight-week period, (2) developed a process flowchart to identify process deficiencies and information requirements, (3) conducted semi-structured interviews, and (4) surveyed a larger group of clinicians to assess their experience with computers and their perceptions about the value of information system options (Tang et al., 1995). The results indicated not just a need for simple patient information but a need for information that was integrated, analyzed, and available when clinical decisions are actually being made.

Cultural and Socioeconomic Factors

Professional Culture and Image

Health care professionals take many of their cues from their colleagues. Thus, acceptance of a new technology by peers as well as opinion leaders may determine a clinician's receptivity to new practices. Most physicians have, however, developed referral patterns to specialists and subspecialists whom they know personally and see periodically on a face-to-face basis in professional or social settings. Telemedicine may disrupt this "culture" and perhaps damage local colleagues economically, as noted below.

In addition, appearances are important in the healing arts, and clinicians may be as concerned and self-conscious as anyone else about their appearance on camera. Because confidence is thought to be reassuring to patients and may, in and of itself, affect patient outcomes, clinicians may be concerned about the possibility that electronic media could weaken the patient's trust.

Nationally, because few programs have demonstrated sustained clinical and business benefits from telemedicine, role models are scarce. Evidence from other areas suggests that respected opinion leaders are important instruments of change because they serve as role models and trustworthy sources of information (or endorsement) for peer-oriented clinicians (Wolinksy, 1988; Soumerai and Avorn, 1990; IOM, 1992a). For those considering the introduction of a telemedicine program, the involvement of a range of specialists from a project's outset can help pave the way to acceptance by a broader community of colleagues.

Lack of Documented Benefit

The scarcity of rigorous evaluations of clinical telemedicine—the stimulus for this report—may also discourage clinicians and other decisionmakers. Little information is available to document how telemedicine can help health care organizations or clinicians improve health outcomes, promote better quality of care, manage costs, attract patients, reduce administrative hassles, or otherwise be of benefit. In addition, practitioners may be concerned that the early adoption of a new and relatively untested technology might be poorly regarded by the people they rely on for support and collaboration. A cautious approach to untested treatment modalities is generally expected of clinicians, and tolerance for "mistakes" in medicine is low. In time, recognized standards for telemedicine practice and direction from accrediting bodies may reduce this concern.

Absent an accessible body of knowledge to draw upon, clinicians and institutions must find their own paths anew. Journals, conferences, seminars, and Internet-based sources are beginning to fill the information vacuum, but the committee concluded from its sampling of these sources that more is sometimes promised than delivered by way of clear, accurate, and usable guidance. Moreover, in an era when health care institutions see each other as rivals not only within but also across communities, the climate for sharing information and experience is not always favorable.

Societal readiness is also an issue. Although some evidence suggests considerable patient acceptance of telemedicine in some settings (e.g., rural areas), it is not clear that patients are generally ready to accept that these new technologies will benefit them. The broader use of telemedicine may require, in addition to evidence

relevant to clinicians and managers, efforts to inform and educate patients and consumers.

Lack of Payment for Telemedicine Services

Added to the uncertainties about the benefits of telemedicine is the important fact that most telemedicine consultations are not covered by Medicare or other third party payers (see Chapter 2 and Chapter 4 for additional discussion). Most of those interviewed by the committee believed this to be a major deterrent to telemedicine use, regardless of whether or not they were advocates of telemedicine or favored a change in payment policies.

Health Care Restructuring

Changes in the American health care system are altering the relationships between clinicians, patients, health care institutions, managed care plans, and public and private purchasers of health care. Strategic alliances, joint venture arrangements, and takeovers are changing historic relationships and centers of control over clinical practice. Practitioners and administrators are acutely concerned about protecting their patient base in the face of cost-driven reductions in the use of many services and changes in referral patterns. Advanced telecommunications technologies stand to alter further the relationships between health care organizations and professionals and between the practitioners and their patients. Will there be gatekeepers for telemedicine applications, and if so, who will play that role—clinicians, health plan managers, government officials, or perhaps the technicians who operate and maintain the equipment? For health care professionals accustomed to assigned roles and responsibilities, questions about who performs new and existing tasks in a networked environment may prompt considerable concern.

What may start as a simple way to improve access through telemedicine may end up as a permanent shift in the locus of patient care—locally, regionally, and even nationally. In the short term, this prospect may lead some to seek policy barriers (for example, licensure restrictions) or other limits on telemedicine practice. In the longer term, however, if telemedicine is viewed by managed care plans and integrated health systems as bringing cost and competitive advantages, they will use their leverage with government officials

and employer purchasers of health benefits to implement telemedicine as they have done with other measures (e.g., discounted fees, utilization review) that are unpopular with clinicians.

CONCLUSION

Those responsible for creating, sustaining, and evaluating information and telecommunications systems and programs face a bewildering and constantly changing array of hardware and software options, many of which are not tailored to health care uses. Assessing the utility of advanced information and telecommunications technologies is difficult, particularly given the need to consider options in combination, not just individually. Although many groups are working to develop hardware and software standards, it remains frustrating and difficult to put together systems in which the components operate predictably and smoothly together, work in different settings without extensive adaptation, and accommodate replacement components.

Getting the components of the human infrastructure of telemedicine to function efficiently and predictably is also a major challenge. The limited adoption of telemedicine is due in part to a variety of what are commonly called "human factors," including a poor fit with the environment, needs, and preferences of clinicians, patients, and other decisionmakers (both individuals and organizations). Clinicians and other decisionmakers may be skeptical of telemedicine's clinical effectiveness as well as its practicality in everyday use. Thus, the scarcity of telemedicine evaluations and evidence of benefits is itself an element in the human factors equation. In addition, those advocating, adopting, or evaluating telemedicine must recognize the uncertainties and even fears that clinicians and organizations may have about how telemedicine will affect them in a period characterized by increased competition, structural realignments, and surpluses of some categories of health professionals.

This chapter has considered some elements of the technical and human infrastructures of telemedicine that evaluators may need to investigate if they are to provide assessments that help decisionmakers determine why a program succeeded or failed and whether and how it might be redesigned to work better. The next chapter considers some policy issues that evaluators may need to consider as they affect the adoption and implementation of telemedicine programs.

4

The Policy Context of Telemedicine

In their early days, most telemedicine programs had relatively low profiles politically. Clinical applications generally did not cross state borders, or if they did, they involved federal government agencies that were not bound by state licensure or liablity policies. The programs did not provoke much legal controversy at either the state or federal level, and decisionmakers, evaluators, and advocates did not appear immediately concerned with possible jurisdictional problems (Shinn, 1975).

Today, even though interstate telemedicine is not necessarily a high priority for many users or potential users, jurisdictional issues relating to licensure and medical liability are generating considerable debate and anxiety. Privacy and confidentiality have emerged as significant policy issues as computer-based patient information systems and databases have proliferated. Public and private policies regarding payment for telemedicine services are regarded by many advocates of telemedicine as a major obstacle. Whether and how such policy concerns are resolved can affect both the benefits and the costs of telemedicine and, thus, the sustainability of telemedicine programs.

At the same time that some governmental policies have posed problems for telemedicine, others have been devised specifically to encourage telemedicine. Such policies include demonstration project

Telemedicine

A Guide to Assessing Telecommunications in Health Care

INSTITUTE OF MEDICINE

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Committee on Evaluating Clinical Applications of Telemedicine

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The serpent has been a symbol of long life, healing, and knowledge among almost all cultures and religions since the beginning of recorded history. The image adopted as a logotype by the Institute of Medicine is based on a relief carving from ancient Greece, now held by the Staatliche Museen in Berlin.

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Section 2: Cultural and Institutional Context of e-Health

Designing a Telemedicine System in Tanzania:

a sociotechnical systems approach

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Introduction

Tanzania contains Africa's highest mountain, Kilimanjaro; its most famous game park, Ngorongoro Crater; its largest game reserve, the Serengeti; and the three largest lakes on the continent lie on its borders. Tanzania embodies the Africa that people envision when they think of Africa. Tanzania is also one of the ten poorest countries in the world, a fact reflected by the woefully substandard state of health care in the country. Deaths from communicable and infectious diseases, which represent only two percent of total deaths in Europe, constitute nearly half of all deaths in Africa. There is a chronic shortage of doctors and other health-care professionals, as well as a lack of national infrastructure to provide transportation and distribution of resources and services. Building health care and educational capacity under these conditions is extremely difficult.

Within this void, Dr. Hubert C. Kairuki, a visionary African Physician, and his family started a four-bed clinic in Dar es Salaam, the economic capital of Tanzania. Dr. Kairuki and his family made significant strides in delivering health care using a unique business model that involved contracting with government owned enterprises to provide health care to their employees on a fee for service basis. In ten years, the clinic grew to become a 130-bed general medical center known as Mission Mikocheni Hospital (MMH).

In 1996, the management at MMH invited a group of faculty and students from The Fielding Graduate Institute in Santa Barbara, California to Tanzania to help assess the viability of their 10-year strategic plan. This nascent, international partnership provided the foundation for developing a plan to link three outlying clinics with a hub site at MMH, mediated by information and communication technology (ICT). This system, used extensively in the United States, laid the groundwork for further study into the feasibility of using telemedicine and telemedicine systems to improve health care capacity in developing countries such as Tanzania.

Statement of the Problem

The "ah-ha" that surfaced between the authors is that working in Africa "really" is different from working in the United States—each of these two different worlds provides unique historical and cultural perspectives about development, health and wellness, health-care capacity and the role of technology. The more we talked, the more aware we

became of the project's reliance on western models of technology and telemedicine as the solution to problems of health care capacity in Africa. That is to say, while the system configuration took into consideration the appropriateness of the technology for the economic development of Tanzania, it focused on telemedicine primarily as a technological tool that would expand the reach of the current health-care system. Furthermore, the initial design seemed to imply that telemedicine systems that work in the western world would work equally well in Africa, and that they would be positively accepted by the Africans themselves.

In health care, there is mounting evidence that the introduction of new technologies invariably creates turbulence within an organization, primarily because the new organizational structures associated with the innovation are not assimilated within the existing status quo. (1) The designers of a telemedicine system must be cognizant of existing patterns of social organization and the likely effect the introduction of new technology will have on those patterns. In addition, these new forms of social organization are likely to be different from place to place and country to country. International telemedicine systems exist within a complex set of cultural environments within which these different social systems operate. Telemedicine systems designed in one culture and social system for use in another are unlikely to work. As Hofstede states in the companion article to this section, "the export of Western – mostly American – management practices and theories to poor countries has contributed little to nothing to their development…and should be sufficient argument to doubt their validity in non-Western environments." (2)

The problem, as we see it, is how to design a telemedicine system so that both the social and the technical systems can function optimally within the cultural environment of Tanzania. In our view, the cross-cultural interface of human beings and information using information and communication technology (ICT) presents enormous challenges and may be one of the major reasons for the failure of telemedicine in developing countries.

In this paper, we will use Sociotechnical Systems Theory (STS) to explore the relationship between a telemedicine system and its cultural environment. The STS approach lends itself well to the onion metaphor on which this book is based. The

analysis and design of a telemedicine system starts with an understanding of the cultural differences between the western technology and consultants, and the Tanzanian users of the telemedicine system. This macro view of a culture, dealing with the cultural and institutional context, is essentially the outer layer of the onion used to structure this book.

As we develop a cultural profile of Tanzania, the complexity of working in multiple cultures and social systems will become clearer—shedding light on other levels of the onion.

A second issue addressed in this paper is the complex role of the international design team. Hofstede, in the accompanying article, suggests that outside experts who believe they can develop a country with their so-called modern management techniques and theories are deplorably arrogant. The consulting model that has been used in Tanzania is proposed as a paradigm for working more effectively in developing countries such as Tanzania.

For purposes of this research, telemedicine is defined as the delivery of health care services where distance is a critical factor, by health care professionals using ICT for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interest of advancing the health of individuals and their communities. (3)

Sociotechnical systems (STS) theory

One approach that has relevance to the design of telemedicine systems is sociotechnical systems (STS) theory. (4) In the STS approach, any work organization requiring the interaction of people and technology rests on two premises: the first is that the desired output is achieved through the joint operation of a social as well as a technical system; and the second is that every sociotechnical system is embedded in an environment that is influenced by a culture, its values, and the roles and norms of its members.

A key feature of the sociotechnical approach to work design is an emphasis on creating work systems in which the social and the technical aspects of those systems are integrated and as supportive of one another as possible. This involves attempting to "jointly optimize" the social and the technical systems that operate in work organizations,

rather than maximizing the functioning of the technical system at the expense of the social system.

Another important feature of the sociotechnical systems approach is recognition of the fact that all organizations are embedded in, and affected by, an outside environment. To understand how an organization functions and to make constructive changes in an organization one must pay close attention to the environmental forces that operate on it. Especially important are cultural values that specify how organizations should function and the generally accepted roles that individuals, groups or organizations are supposed to play in society. There is constant interchange between what goes on *within* any given work organization and what goes on in its environment, — a fact that is dangerous to ignore when work systems are designed or changed.

The Cultural Environment of Tanzania

As generally understood, the culture of a society comprises the shared values, understandings, assumptions, and goals that are learned from earlier generations, imposed by present members of a society and passed on to succeeding generations. (5) Despite differences among social scientists, there are three characteristics on which there is widespread agreement: "…it is not innate, but learned; the various facets of culture are inter-related—you touch a culture in one place and everything else is affected; it is shared and in effect defines the boundaries of different groups." (6) This shared outlook results in a basis for living grounded in shared communication, standards, codes of conduct, and expectations.

Just as organizations can be portrayed as sociotechnical systems, cultural environments can best be understood as systems composed of interrelated parts, or subsystems. To achieve understanding of any given culture requires some familiarity with the cultural variables universal to most cultures—language, religion, education, social organizations, the economy, politics and law, technology, and values and attitudes. (7) From these universal variables, one can develop a cultural profile which identifies the specific differences found in each country or people and hence, anticipate how the unfamiliar culture will impact the organizational setting.

Using information available from government and university reports, the following sections show how these universal variables can be used to describe the cultural environment in Tanzania.(8)

Overview. The United Republic of Tanzania is one of the world's least developed nations. Situated on the East Coast of Africa, bordering the Indian Ocean between Kenya and Mozambique, it is slightly larger than twice the size of California. The largest city is Dar es Salaam; Dodoma, located in the center of the country, is the newly designated capital. Tanzania's population of 37.2 million is growing at 2.6 percent annually. About one-third of the population lives in urban areas, and more than half of all Tanzanians are younger than age 20. Ninety-nine percent of the population is African, coming from some 130 ethnic groups. An estimated 70,000 Arabs and 10,000 Europeans reside in Tanzania, with Arabs most numerous on Zanzibar. People of Lebanese, Palestinian, and Indian origin dominate the merchant/trader class. Significant refugee populations from neighboring countries live in border areas.

Language. Swahili (Kiswahili), the primary official language in Tanzania, was developed along the coasts of Kenya and Tanzania as a trade language between Africans and Arabs. It is a mixture of various Bantu languages, Arabic, and English. English, the second official language, is used in business, government, and higher education.

More than one hundred languages are spoken in Tanzania. Most people speak the language associated with their ethic group, but they generally also speak Swahili. Julius Nyerere, the country's first president, made Swahili official at the time of independence from Britain, to foster pride in the people's African identity.

Religion. On the mainland, more than one-third of the population is Christian. Another third is Muslim. On Zanzibar, nearly all inhabitants are Muslim. About one-third of the population follows indigenous beliefs, although many of these people have also accepted some Christian or Islamic tenets. It is not unusual for professed Christians to mix their beliefs with local traditions. Thus, a local priest and a traditional healer might carry equal respect in a "Christian" village. The two belief systems are not considered contradictory because each has a place in the people's daily lives. The government is neutral in religious matters and has tried to promote religious tolerance throughout the country.

Education. About 70 percent of all school-aged children begin primary school but fewer than 10 percent progress past the seventh grade. Boys are more likely than girls to get an education. As a result, there is a wide disparity between the male and female adult literacy rates, being 84 percent for males and 66 percent for females. There are several structural problems that cause difficulties in the education system. Primary school instruction is in Swahili, but English is the main language in secondary schools. As a result, students must change languages when they move to secondary school. There is also a chronic shortage of secondary school classrooms and teachers, so that students who would attend can't find room. Also, the government imposes a tax on students who attend secondary schools, which many parents can't afford to pay.

Economic system. Until the mid-1980s the country was committed to a socialist economy that Julius Nyerere optimistically hoped would foster political and economic self-reliance. However, world economic and political issues, together with serious blunders on the part of the Tanzanian government, contributed to a failed effort. The Government of Tanzania has since embarked on a program of free-market reforms and has sold off most of its poorly performing parastatal businesses.

Agriculture still dominates the Tanzanian economy, employing 85 percent of the population and accounting for 85 percent of all exports. The industrial sector, which accounts for only about 10% of GDP, is one of the smallest in Africa. Economic liberalization has encouraged private investment and the creation of new export products. Continued democratic reforms are expected to boost economic performance. However, corruption, mismanagement, and regional problems still hamper the economy.

Tourism is a growing segment of the Tanzanian economy, accounting for 7.6% of GDP. The segment is rapidly growing, increasing 22% since the early 1990's, and brings in significant foreign exchange, e.g. $392 million in 1997 and $570 million in 1998. The government of Tanzania has established a National Tourism Policy and has set aside 25% of the land for wildlife and botanical sanctuaries, with the goal of attracting one million tourists a year by 2010. The government estimates that this will increase the sector contribution to GDP to 25%, however significant investment in infrastructure, promotion and service skills must be made in order for this goal to be reached.

Women tend to enjoy equal access with men to income. Overall, however, people have limited availability of resources and opportunities necessary to pursue personal goals and rise above poverty. Half of the population lives in poverty and the real GDP per capita is $501. To generate some cash income, a family will often run an informal shop that sells produce, soda, soap, and sundries, or they may find odd jobs to supplement low-paying wages.

Political and Legal System. Tanzania is a democratic republic following a political union between Tanganyika and Zanzibar in 1964. It has three branches--an Executive, Legislative and Judicial, and contains 25 regions. The president (Benjamin Mkapa) is chief of state, and the Prime Minister (Frederick Sumaye) is head of government. The National Assembly (Bunge) has 274 seats, 42 of which are reserved for appointees or specific officials. The voting age is 18. A five-level judiciary combines the jurisdictions of tribal, Islamic, and British common law. Zanzibar is a semiautonomous state with a separate parliament and elected president (Amani Karume)

The Technology Infrastructure. The ICT infrastructure in Tanzania is undergoing rapid modernization, and is no longer the major barrier it has been to the spread of email and full Internet services. The capital city, Dar es Salaam, has seen dramatic improvement of the local infrastructure, with many digital exchanges being installed, the availability of two cellular telephone networks, and now, a half dozen internet service providers.

Nevertheless, network access in areas outside Dar is still very limited. The multi-donor funded Tanzanian Telecommunications Restructuring Programme (TRP), responsible for much of the improvements in Dar, is also upgrading the links to many secondary towns. Fiber cable is being laid in Moshe and Arusha and the Dodoma-Dar-Zanzibar-Tanga-Moshe-Arusha microwave links are being digitized, as are links to Morogoro and Mwanza. Currently, telecommunication links in northern Tanzania (Arusha) are more reliable to Kenya than to the capital in the South. (9)

Value Dimensions

Values are a society's ideas about what is good and bad, right or wrong, and will influence people to behave differently under similar circumstances. As a powerful component of a society's culture, values are communicated through the subsystems

described above and are passed from generation to generation. Most of the variations between cultures stem from underlying value systems, which cause people to behave differently under different circumstances. One framework for understanding how basic values underlie organizational behavior was proposed by Geert Hofstede, as the result of his research on over 116,000 people in over 53 countries.(10) Hofstede, who describes culture as the "collective programming of the mind," identified five independent dimensions of national culture differences. He suggests that these five dimensions of values -- each rooted in a basic problem, with which all societies have to cope, but on which their answers vary -- can explain the differences among cultures. The dimensions are as follows: (1) individualism versus collectivism, (2) power distance, (3) uncertainty avoidance, (4) masculinity versus femininity, and (5) long-term versus short-term orientation.

Individualism refers to the tendency of people to look after themselves and their immediate families, rather than others. Collectivist cultures value the overall good of the group. The expectation is that people will subordinate their individual interests and needs for the benefit of the group. Hofstede's findings indicate that most countries scoring high on individualism have both a higher gross national product and a freer political system than these scoring low on individualism. Additionally, all countries scoring low on individualism score high on power distance. Tanzania, which scores low on individualism, predictably is poor and has an unequal distribution of power. In Tanzania, people typically look after each other in exchange for loyalty, emphasize belonging, and make group decisions. Because being part of the group is so important it is often very clear how people in the group should behave.

Power distance is the extent to which less powerful members of organizations accept that power is unequally distributed. It ranges from small to large. A small power distance society such as the U.S. is less comfortable with power differences such as social class distinction or organizational ranking. In a large power distance culture, differences among people with different ranks are accepted, and an individual's societal or organizational position influences how he acts and how others treat him. In Tanzania, a person in a high-level position treats those at lower levels with dignity, but the differences in rank are always clear. Delegating decision-making implies incompetence

because the rank of a high status person requires him to make decisions himself. Employees in countries that rank high on power distance are more likely to prefer an autocratic leadership style and some paternalism because they are more comfortable with a clear distinction between managers and subordinates rather than with a blurring of decision-making responsibility.

Uncertainty avoidance, which ranges from strong to weak, focuses on the level of tolerance for uncertainty and ambiguity within the society. A low uncertainty avoidance ranking indicates the country has less concern about ambiguity and uncertainty and has more tolerance for a variety of opinions. This is reflected in a society that is less rule-oriented, more readily accepts change, and takes more and greater risks. Strong uncertainty avoidance countries like Tanzania have a low tolerance for uncertainty and ambiguity. This creates a rule-oriented society that institutes laws, rules, regulations, and controls in order to reduce the amount of uncertainty. Such countries have a high need for security, concern for doing things correctly and great respect for experts.

Masculinity refers to the degree of typical "masculine" values, such as assertiveness, materialism, and lack of concern for others. Femininity in a society emphasizes concerns for others, relationships with others, and quality of life. A high masculinity ranking indicates the country experiences a high degree of gender differentiation. In these cultures, males dominate a significant portion of the society and power structure, with females being controlled by male domination. A low Masculinity ranking indicates the country has a low level of differentiation and discrimination between genders.

Long-term versus short-term orientation is a new dimension of national cultures that is independent of the four originally identified by Hofstede. Based on a Chinese Values Survey (CVS) developed by Michael Harris Bond, it appears to be based on items reminiscent of the teachings of Confucius, and refers to a valuing for persistence and thrift. East Asian countries scored highest on LTO while Western countries scored on the low side. Some Third World countries scored the lowest.

In an attempt to explain why Africa, and particularly southern Africa, remains a "development economist's headache," Hofstede set out to determine if there might be an "African dimension" that would help to explain why Western recipes for development

don't seem to work in Africa. (10) Development of an "African Values Survey" failed to produce any new independent dimensions, but one factor opposed the African to the Asian countries on long-term orientation and thus did provide a possible explanation for their differences in development rate. This factor, called "Wisdom," was comprised of items such as: "It is important to show hospitality to strangers"; "Wisdom is more important than knowledge"; "Wisdom comes from experience and time, not from education" and "It is better to discuss a decision than to impose a decision." Attributed wisdom that is not based on knowledge and education, however, is a dubious foundation for the development of a country. In his book, *Dark Star Safari*, travel journalist Paul Theroux provides a vivid description of the wisdom versus knowledge divide in Tanzania:

> At one small halt in this great sun-baked emptiness a single tree grew, a mango of modest size but leafy with dense boughs. There was a circle of shade beneath it. Within that circle were thirty people, pressed against one another to keep in the shade, watched by a miserable goat tethered in the sunshine. What looked like a group game was obviously an afternoon routine of survival. As interesting to me as this packed-together mob of villagers around the lone tree trunk was the idea that no one in this hot exposed place had thought to plant more mango trees for the shade they offered. It was simple enough to plant a tree—this mango itself contained a thousand seeds—yet no one had planted one, or if anyone had, the tree had been cut down. The sight of these Africans in this tiny place in central Tanzania struggling to keep within a patch of shade stayed with me as a vivid instance of forward planning, or rather the lack of it. (11)

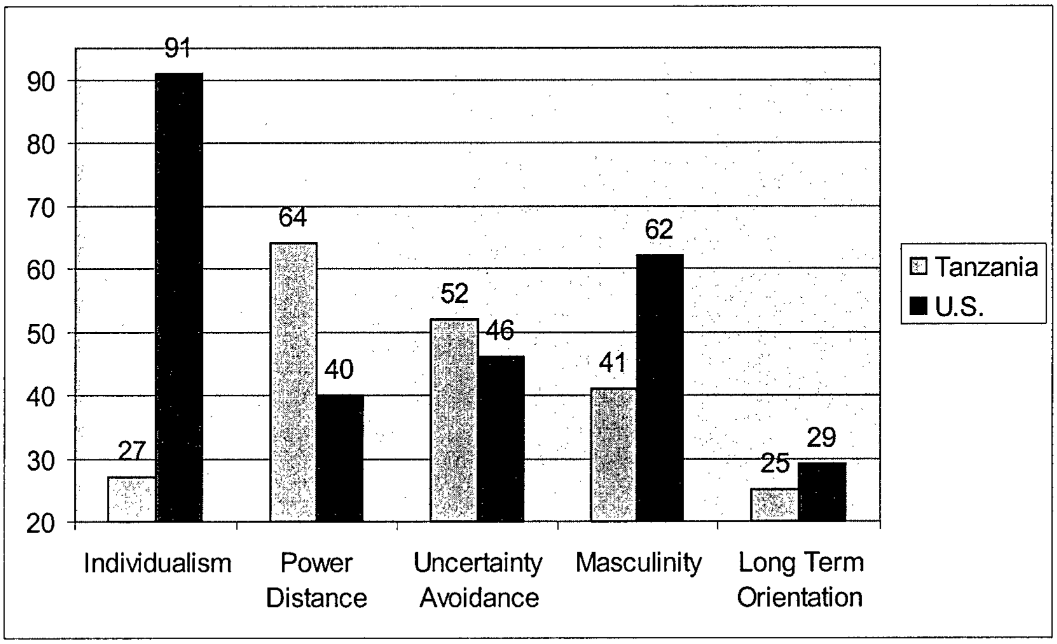

Figure 1. Hofstede's Cultural Dimensions

Comparing the cultural profile of Tanzania to that of the U.S. on Hofstede's five dimensions, one notes significant differences on several dimensions. (see Figure 1) While the United States can be described as very high on individualism, and low on power distance, Tanzania is a culture high on collectivism (low individualism). As with most collective cultures, it is a poor country with high power distance. Thus, an individualistic telemedicine designer from the U. S, with low power distance will dominate a collectivistic African who sees the American as "in charge." The low scores on long-term orientation for Tanzania convey a valuing for wisdom rather than knowledge and education. Importantly, the level of education is very low, with only a small percent of people attending high school. This fact reinforces the African's view of westerners as experts in telemedicine design. The scores for uncertainty avoidance are similar; however, the reasons are quite different. Tanzanians are comfortable with uncertainty because they tend to believe that what happens to them is due more to fate and chance than to their own ability to exert control and effect change. People in Tanzania tend to embrace feminine values such as looking after one another, and being polite and modest in behavior. A masculine approach to telemedicine design stresses the

latest in gadgets and technology as being best. One might conclude that such a profile places Africans in a subservient position when dealing with westerners on a design team. While over-simplified, many of the points raised in this cultural profile are a harbinger of the social norms uncovered in the next section.

The National Health Care System

The health care system in Tanzania is multi-leveled, and includes government owned facilities, private hospitals and clinics and traditional medicine practiced in the villages. The patient has the option of going to a government clinic or hospital, a private hospital, the village healer or some combination.

The government of Tanzania owns and operates a series of clinics and hospitals that operate on a western, disease oriented model. They were developed during the post-colonial socialist period and were heavily supported by development agencies. With the reduction in the level of aid, the quality of the government system of clinics and hospitals has deteriorated. The system tends to be substandard compared with comparable western systems.

The government of Tanzania has a health care policy that also includes private hospitals. However, these hospitals serve specific constituencies and are generally not open to the ordinary Tanzanian villager. This is so because the lack of physical infrastructure, such as roads and public transit, prevents the villager from getting to the private clinic, and economics such as the cost of drugs and other resources, prevent him/her from being able to purchase the services that are uniquely available at private clinics.

At the village level, the primary health care system is administered by traditional health care providers using a magico-religious belief system. In the magico-religious approach, health and illness are closely linked to supernatural forces. Mystical powers, typically outside of human control, cause health and illness. (12) Traditional medicine consists of two broad categories of preventive/protective and curative activities. Oral treatments -- what we in the west would consider magic -- are combined with medicinal herbs to promote health and cure ailments. (13)

<u>Family and Gender Roles in the Health-Care Context</u>. The health care system in the United States typically focuses solely on the individual patient as the source of a

medical problem in need of a cure. In a collective and group-oriented culture such as Tanzania, the family assumes a large role in the functioning of the health care system and the interaction of the two systems can be the basis of serious problems and misunderstandings. Cultures that value the community or the extended family, for instance, may require the involvement and agreement of other family members, not just the patient. They also may influence people's willingness to keep important health-care appointments.

Many cultures have strong expectations about modesty, and the bodily displays of women can make the medical examination itself a source of intercultural difficulties. In some cultures, role requirements governing appropriate behaviors for women do not permit undressing for an examination by male physicians or nurses. (12)

Conversational Structures and Language. Because of different interaction norms, the medical interview between caregiver and patient can be another source of intercultural communication problems. Some collective or high context cultures may engage in extensive small talk before indicating their reasons for the medical interview. Similarly, direct and explicit discussions may cause the patient discomfort, while the use of indirection or other face-saving strategies may be preferred. In many cultures, doctors are perceived as authority figures with which one must agree in the face-to-face medical interview. A patient may know that he or she will not be able to follow a proposed treatment plan but will be reluctant to respond to the doctor in a way that might appear to be a challenge to the doctor's authority. (12)

The Health-Care Scenarios -- The Social Systems

In order to understand more clearly how the cultural environment would influence the behavior of individuals within the social system in the Tanzanian culture, a series of health scenarios was developed to test various hypotheses about how patients, doctors and nurses would respond to common health care situations. Each scenario envisions a fictitious patient living in an African village who is faced with different kinds of health problems of varying severity.

Interviews were conducted with African Nationals studying in the U.S. who had experience with, and knowledge of, health care practices in their home countries. Their

responses were analyzed for information to expand and enrich our understanding of the socio-cultural environment. The issue for the respondents was to report what each of the participants in the scenario was thinking or doing, and how he/she would react based on the respondents' African heritage and the availability of health care choices. From the interpretations provided by the respondents, characteristics of the social system were identified and probable role expectations regarding the primary participants in the system -- the doctor, the nurse and the patient -- were deduced.

First Scenario – Different Realities. The first scenario dealt with the treatment of common ailments, such as malaria. Respondents were asked to describe the steps a mother might take to obtain treatment for her child.

The respondents reported that, as the first line of defense, the mother or patient would use traditional medicines—such as herbs and barks, to treat the illness. They, themselves, were familiar with these traditional remedies, and viewed them as a basic requirement for daily life. It was suggested that the patient might go to a clinic if the treatment using the traditional approaches to the symptoms didn't work. The decision to go to a western clinic, however, generally is made after consultation with other family members or parents, and frequently with input from the tribal elders.

When one person is ill, the rest of the village observes the treatment, which may be western medications, traditional herbs or some combination of both. The knowledge gained, good or bad, becomes part of the collective wisdom of the village and will be used the next time someone contracts the same illness.

The decision regarding which combination of traditional and western medicine to seek depends not only on the patient's predisposition toward traditional medicines and their effectiveness, but also on the patient's perception of how well he or she will be treated at the western clinic and whether he or she can afford the cost. Generally, the patient will only go to a clinic for treatment: if the illness doesn't respond to traditional approaches; if a clinic is available; if the patient can afford treatment and medications; and if the medications are available at the clinic. Since there are more clinics in the cities than in the rural areas, the probability that patients will access western, clinic-based health care is greater in the urban areas.

The respondents discussed the deterioration of western health care in many African countries over the last several years. As the health-care capacity of these countries has declined, so too has trust in western health-care. As reported by the respondents, the general population does not have a very positive perception of health-care workers. They are perceived as poorly trained and not well motivated. The perception of doctors is better, but the chronic shortage of doctors in most African countries makes this a moot point.

Several critical themes emerged from an analysis of the responses to the issues posed in this scenario. The most important was that most patients in a village setting within developing African countries hold different perceptions of reality when it comes to health care than do doctors and nurses. The patient is part of a village based social system, which embodies a traditional view of health care, while doctors and nurses, trained in a western tradition, are part of a different social system and see health care from a different reality. A way must be found to reconcile these two realities before a telemedicine system can be successfully introduced.

The second theme to emerge is the existence of economic and structural boundaries that make access to western medicine difficult for the patient. Western based health care systems in developing countries are often of poor quality and unevenly distributed between urban and rural populations. There is also the perception that nurses, and to a lesser extent doctors, are incompetent and poorly motivated, and corruption is rampant in the health care system. Both themes provide powerful barriers to the introduction of telemedicine in countries like Tanzania.

<u>Second Scenario -- A Stranger in a Strange Land</u>. The patient in the second scenario has an illness that has gotten worse and hasn't responded to traditional remedies. She visits a local health care clinic, which is linked to a doctor using ICT. This scenario introduces the concept of a teleconsult or health care delivered from a distance, using technology.

The responses to the second scenario point out many of the communications difficulties that ensue when technology becomes the channel through which the patient in one social system is expected to communicate with a doctor in another. It was suggested that mediation of the communication process with an ICT system and an unfamiliar

doctor would tend to confuse and frustrate the patient. Respondents felt that the patient would have a problem trusting a doctor that is seen for the first time on a TV screen. They also stated that trust and communication might improve if the doctor were introduced to the village people and posted his/her pictures around the village as a way to become "real".

The scheduling aspects of telemedicine consults are more crucial than with face to face medicine because the patient and doctor must arrive at two different places at the same time. A precise schedule conflicts with the more casual concept of time held by Africans who don't feel the need to keep track of it and manage it as westerners do. This pertains not only to the patients but to the health care workers as well. In addition, the patient who lives far from the clinic will have difficulty arriving on time for an appointment because of the poor physical infrastructure in many African countries. Both of these issues may hamper enforcement of a strict telemedicine schedule.

It was generally felt that the presence of a camera in the exam room would be perceived as an invasion of the patient's privacy. In Muslim and some tribal cultures, taking pictures is considered rude and socially unacceptable; disrobing in front of the camera is even more unacceptable, particularly if the patient has not met the doctor face to face at some point.

Several themes relating to cross-cultural communications emerged from the issues posed in this scenario:

1. High Context vs. Low Context Cultures. Tanzania is a high context culture where the communication between patient and healer typically entails a silent language that transmits shared meaning about the relationship, trust, time, collectivism and religion. In a telemedicine system, with technology as the channel of communication, the environment becomes low context and challenges most of the attitudes and behaviors inherent in the traditional system. Typically, when familiar cues are removed from the communication context, the person experiences anxiety and culture shock.
2. Trust vs. Professionalism. A "doc in a box" replaces face-to-face interaction between patient and healer. The trust in another person

nurtured throughout a long-term relationship is replaced by distrust in strangers one has not met before.

3. Time: Monochronic vs. Polychronic. The polychronic pace of time in the village is replaced by the schedule of a western organization. Lack of transportation and telephone systems militate against getting to an appointment on time. The more relaxed concept of time that ensues in most collectivist cultures, where primary importance is put on relationships, runs counter to the rules of scheduling that protect the valuable time of the doctor.
4. Rules of Modesty. Finally, the rules of modesty inherent in the religious beliefs are seriously compromised if the patient is expected to disrobe or bear parts of her body before a stranger. The issue of being photographed by a movie camera raises additional taboos.

Third Scenario - An Ethical Dilemma. The third scenario deals with the treatment of a life threatening illness such as HIV/AIDS, and raises the issue of moving a dying patient from one social system, the tribal village, to another, a western hospital.

In this situation, as with the others, the predisposition of the patient is to consult with the traditional healer first. In this case, however, the family might seek help from western medicine when the traditional medications don't work. The patient will still balance the advice of the doctor with that of the healer when deciding what combination of care to follow.

Traditional healers generally do not have the capability of diagnosing HIV; therefore, when AIDS develops, the traditional healer will often misdiagnose the illness as the flu or some other common ailment and treat accordingly. When the treatment doesn't work, the patient will likely believe he is cursed, which will be confirmed by the traditional healer. The healer will use magic to attack the curse that he perceives within the patient and his family. When magic fails, the patient is faced with two choices. He may give up and die or, he may go to a western hospital for treatment. At the western hospital, fear of the AIDS virus isolates the patient from other patients and the hospital staff, and because of lack of effective treatment, the patient dies, essentially alone.

The most important theme to emerge from this scenario is the ethics of taking the patient from a social system in which he is cared for to one in which he obtains medical care. A treatment that imparts fear, isolation and death seems far less humane than one in which the patient dies with support from family and tribal members. Neither cures the illness but the death that follows traditional medicine seems more humane than the one that results from western medicine. If no cure exists, is it better not to know and die with hope or is it better to hope and die in isolation? The responses to the scenarios confirmed that the social system is far more complex than originally conceived.

Characteristics	**Traditional Health Care**	**Western based Health Care**
Location of Health Care Delivery	Village Based	Hospital and clinic based
Concept of health and wellness	Magico-religious	Disease model
Treatments	Traditional medicines	Western medicines
Practitioners	Traditional healers	Doctors, nurses, technology
Family roles in health care	Patient and family are partners in decision making	Patient carrier of disease to be cured
Communication Patterns	High context, Trust Polychronic time	Low context Professionalism Monochronic time

Figure 2. The health subsystems in Tanzania

The system consists of two health sub-systems, traditional and western, populated by people with two separate paradigms of health and wellness. (see figure 2) Rather than being part of the same social system, the doctor and nurse are part of the western

subsystem while the patient is in the traditional subsystem. In order for telemedicine to work, the barriers separating these two subsystems must be bridged.

The Technical system

The technical system should be designed to address the two primary criteria of the Sociotechnical systems approach. It should be optimal for the cultural environment in which it operates and compatible with the health-care related social systems.

Designing an optimal system does not mean using the most advanced technology available, but rather using technology that is appropriate for the local environment. Generally, the key is that the technology should suit the level of development in the country, as well as the specific site at which it is installed. According to Field, the technology components of a telemedicine system should be off-the-shelf, rather than customized; have a low level of sophistication to learn and operate; and be individually upgradeable. Also, each component must be compatible with all other components. (14) In addition, the design team identified two additional characteristics required for the technology to function in the national subsystems of Tanzania. The technology must be inexpensive to purchase and maintain, and it must be compatible with local telephone infrastructure and upgradeable if and when the infrastructure has improved.

The other consideration has to do with the joint operations of the technology with the social systems in Tanzania. The design team addressed the issue of compatibility with the health care social systems at MMH. The following are some of the preliminary design criteria that were identified:

- The patient and the doctor must be able to see each other in real time.
- Data, both text and pictures, must be able to be transmitted quickly and accurately, while the patient is still at the clinic.
- There must be a simple way of maintaining and accessing a patient record on both ends of the technology.
- Running counter to the above three requirements of the social systems, the technology must be complex and expensive enough so that the people using it *perceive it* as a valuable addition.

A demonstration system, using a hub and spoke technology design emerged from the process. Cameras, computers, the Internet and the local telephone infrastructure

satisfied the basic requirements for an effectively functioning technology system. (see Figure 3) The result was a combination system consisting of a camera at each site to transmit and receive live interactive video between sites, and a computer with a web cam to capture and transmit video clips and still pictures over the internet as attachments to emails. Email was used as the vehicle to transmit written data with the pictures. A modified contact manager data base was used as the patient record for the purposes of a demonstration, understanding that this part of the technology needs further refinement.

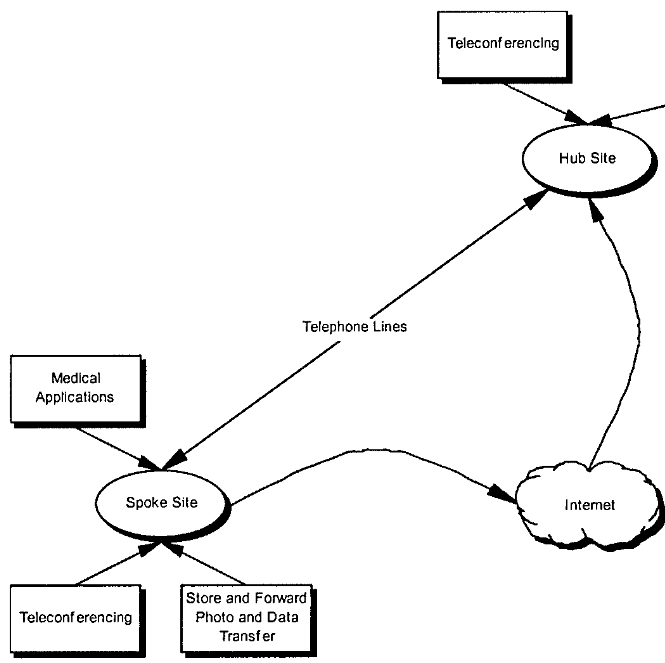

Figure 3. Hub and Spoke Technology

The Kairuki Mikocheni Consulting Model (KMM)

The partnership forged between the Kairuki family and the North American team resulted in the development of a new consulting model which has been used throughout the intervening years to percolate innovation at Mission Mikocheni Hospital. (15) Placing a telemedicine system into a developing country such as Tanzania is far more

difficult than first envisioned. It requires skill in negotiating the myriad socio-cultural boundaries discussed earlier in this paper, as well as technical knowledge and expenditure of energy over a significant period of time. Conventional consulting models haven't worked in Africa, primarily because they stress technical solutions to problems that have their roots in the cultural environment. The model that emerged from this partnership provides an alternative paradigm in which an international consulting team of both western and local partners can collaborate to design and develop an effective telemedicine system.

The model is based on participative Action Research (AR), with several important additions. Action research is a methodology by which meaningful work is performed and through which solutions to problems emerge. It is a process by which real world problems in a society can be addressed by the people who have to live with the solutions they develop. Because of its emergent nature, new methods of practice and theory are brought into focus. The process of AR is cyclical and consists of five elements – diagnosis, action planning, action taking, evaluation and learning. The researchers move back and forth through the elements in a somewhat messy process from which answers become apparent. In more complex social change processes, as described here, the learning that emerges from one solution often opens up new issues to explore. Thus, the KMM adds a linear component as well as the cyclical one, to the AR process. (see figure 4)

An international organization of equal partners, called the Client Consultant System Infrastructure (CCSI) is the cornerstone of the structure of the KMM. It is through this ad hoc organization that innovative work is done. Its defining characteristics, what Maturana calls criteria of distinction (16), are as follows:

- an ad hoc, multinational, multicultural, social entity of equal partners
- oriented toward the goal of improving health care access and capacity
- structurally coupled to multiple environments with different cultures

People may move in and out of the CCSI as needed, but the members are equal partners in the consulting process. In this model, the role of the consultant is significantly different from the expert model of consulting typically used in Africa. In the expert model, the consultant is assumed to be able to diagnose the problem and implement a solution that

both the client and the consultant assume will work. The consultant remains separate from and outside the client system. In the KMM, by contrast, the consultant actually becomes a member of the client system, and fills different multiple roles as required, such as facilitator, teacher, resource coordinator and even dream weaver. Rather than being experts from afar, promoting inequality and dependence, the consultant becomes a participant in a group process.

The success of the CCSI is enhanced by a process of structural coupling. Maturana defines structural coupling as recurrent interaction that produces structural changes in the interacting entities. (16) The key activity in this concept is the mutual recurrent interaction that results in the structural linking of the parties. Practically, it means sleeping in your host's house, eating what he eats and developing empathy for the life he leads and the difficulties he faces. It means listening to his stories and telling him yours until you both create a common world. This recurrent interaction changes both participants, not only linking them to each other but to each other's environment as well. The process of structural coupling is the glue that holds the CCSI together and maintains its links to the various cultural environments.

The final component of the KMM, the interlude, is an outgrowth of the consultant being inside the CCSI as a participant, instead of outside as an observer. While an insider, the consultant can interact with other insiders, e.g. the client system, and facilitate the change within the AR model. In the process, however, the consultant gives up the privileged position as a researcher that allows him/her to understand the relationships between the client system and its environment. The interlude, a time between periods of activity when members of the CCSI are not working as a unit, is a period of reflection in which the participant/consultant withdraws from the system and examines what has been accomplished in the role of researcher/observer. (15)

The model described here addresses the cultural and social issues raised earlier in this paper. Because the CCSI is an organization of equals who are structurally coupled to each other and to the multiple social systems and cultural environments that exist in an international telemedicine project, the barriers to communication and to cultural understanding are more likely to be overcome and the misunderstandings that result from individuals interacting from different cultural vantage points are lessened.

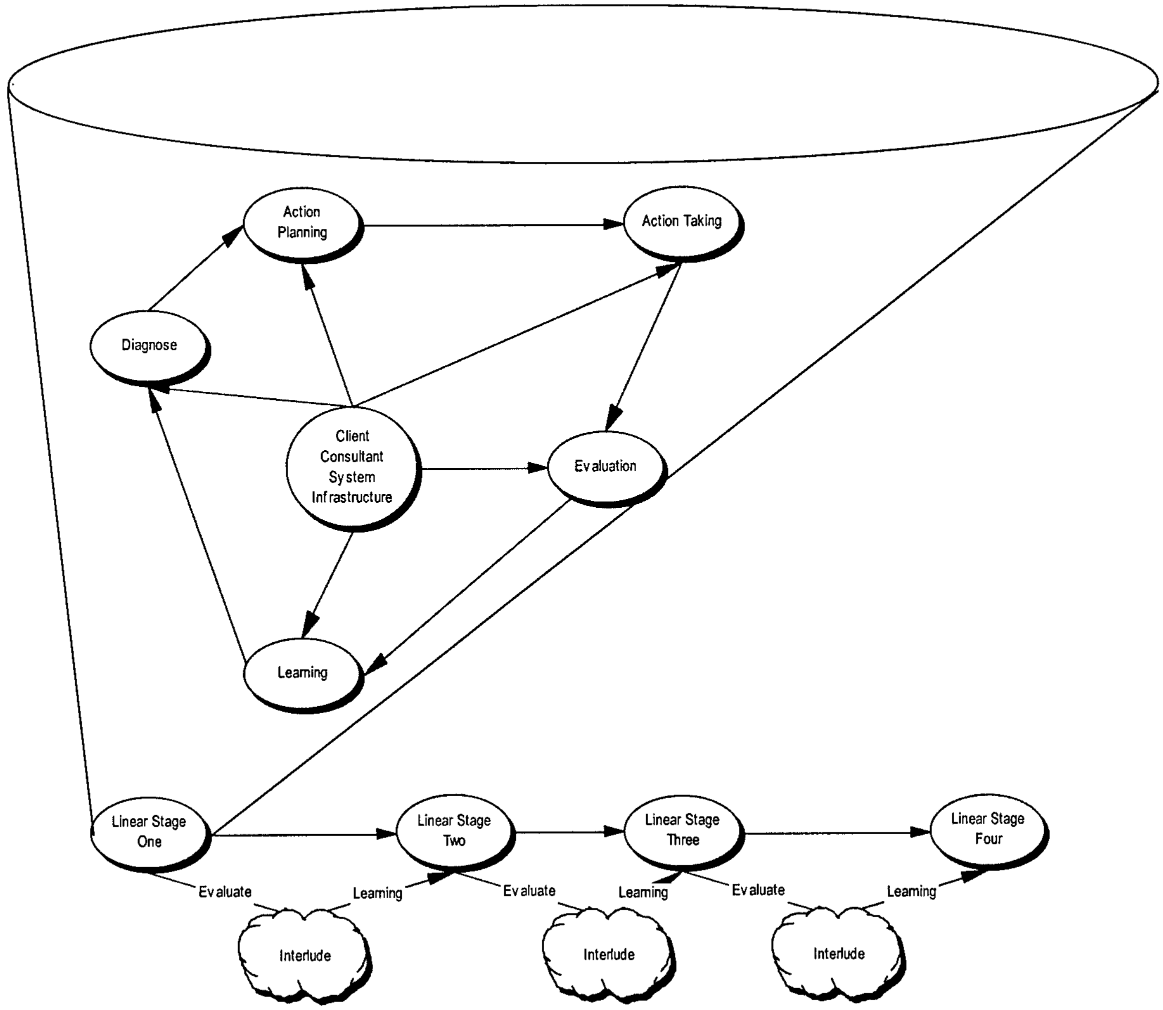

Figure 2. The KMM Consulting Model

Summary and Conclusions

This paper shows that placing a telemedicine system into a developing country such as Tanzania is far more difficult than first envisioned. The cross-cultural interface between the western technology and consultants and the local health care users of the telemedicine system presents enormous challenges that must be addressed if telemedicine is to succeed in developing countries.

Using the sociotechnical systems approach, we developed a cultural profile of Tanzania to describe what Hofstede calls "the collective programming of the mind." An analysis of the cultural environment and the national values in Tanzania identified several critical differences between western cultures and the culture of Tanzania. Subsequently, we developed a series of health-care scenarios to provide us with additional information about the social system in which health-care functions in Tanzania. Analysis of the responses of a group of African nationals to the scenarios indicated that significant differences exist between social subsystems. These differences serve as barriers to communication and cooperative efforts. In several important ways, the use of technology accentuates these barriers. Ways must be found to transcend these cultural and social boundaries if telemedicine is to work.

The second challenge addressed in this paper is the complex role of the international design team. It was noted that telemedicine consultants are frequently from a different country and cultural background than are the user. Unless they are aware of the cultural differences operating in the host culture, they unintentionally build failure into the system design. Compounding the problem is a national proclivity in many African countries to accept the superiority of the solution coming from outside experts. Finally, a telemedicine system is often expected to operate on an inter-country basis as well, where a consult may take place between a physician in a medical facility in the United States and a physician in an urban hospital in Tanzania. A collaborative action research-based model, such as the Kairuki-Mikocheni Model, provides a way for multiple social systems and cultures to develop a working relationship, potentially overcoming the barriers that isolate cultures and social groups. It empowers multi-national designers and practitioners to structurally couple with the disparate cultural environments and health subsystems and stands the best chance of allowing an appropriate telemedicine system to develop.

In conclusion, telemedicine systems that attempt to function across national boundaries must integrate various understandings about differences in cultures, health subsystems and paradigms of health and wellness. The system is vastly more complex than most design consultants envision. As Hofstede states in the companion article to this section, "assuming that with so-called modern management techniques and theories

outsiders can develop a country has proven a deplorable arrogance. At best, one can hope for a dialogue between equals with the locals, in which the western partner acts as the expert in western technology and the local partner as the expert in local culture, habits and feelings." (2) The challenge in the development of telemedicine is to develop the dialogue among equals. The relationship between consultants and the funders who develop telemedicine, on the one hand, and the users of telemedicine, on the other, make the dialogue inherently unequal. Collaboration with local partners in development and implementation of telemedicine systems doesn't make the inequality disappear. The perception of inequality persists, institutionalizing the actual inequality. Hofstede emphasizes that cultural infrastructure cannot be pressure-cooked, it takes time to grow. In our view, however, cultural infrastructure will not grow by itself. It has to have a vehicle to transcend the boundaries that exist between cultures.

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E-HEALTH FOR DOCTORS IN RURAL AND URBAN INDIA

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The Information Age has made profound changes in the society and is gradually penetrating into the healthcare segment. The Internet, the World Wide Web (www), and telemedicine are some of the significant areas where rapid transition is occurring. Millions of physicians, healthcare providers, and patients are accessing the web daily for patient information, consultation, and distance learning.[1]

Since India's independence from the British rule in 1947, the country has made significant progress in the field of health and its delivery to the masses. For example, Smallpox has been completely eradicated, the infant mortality rate has been brought down, life expectancy has gone up, pre and postnatal care facility has improved and there is overall progress in disease control and establishment of modern health infrastructure. [2] High standard of healthcare comparable to that occurring in the developed countries are being offered to patients at affordable costs. There is scope for improvement in practically every area of health care. Each day, the numbers of online medicine-related documents grow, and many can be accessed via the Internet. This powerful free-flow of information holds the promise of improving the standard of healthcare in many ways. [3]

Information technology has played a vital role in hastening the spread of healthcare to urban and rural areas in India. Internet – 'an interconnection of networks' has revolutionized the communications world like never before.[4, 5]

Background to our projects

Medical advice through correspondence, letter, etc. has been in practice for several years. It is a routine system to communicate with letters to referring doctors. These letters used to be thorough, extensive and very informative pertaining to the care of patients referred. The patients were encouraged to follow the guidelines given in the letter and keep in contact with the doctors as and when needed. In fact, this system of communication got so well established that it was expected of all consultants to follow this procedure. Failing to do so, called for punitive measures from the hospital board. The busy resident doctors in the hospital are encouraged to discuss patient problems on phone with senior consultants and put this in writing with the date, and time on the case file. Thus it is possible to offer high quality service to patients on a regular basis (Personal Communication, CB Sridhar, 2002).

Doctors providing tips on diagnosis or treatment of ailments through newspaper columns or through radio and TV broadcasts also hardly need a reminder because they are so widespread. Telemedicine through correspondence involved considerable time lapse between the patient's query and the advice of the doctor, but protected the privacy of the patient. The response to the queries through radio and TV broadcasts accelerated the spread of information and like the newspapers had the advantage of being both specific to the query as well as it being shared by other members of the audience.

At present, e-health is put to use for a variety of purposes. Some of the more common purposes include: (1) Remote consultation; (2) Second opinion; (3) Interpretation services; (4) Continuing

education and exchange of clinical information; (5) Home care and (6) Online surgery in some very rare cases. Of all these, the first three are the more common uses the world over. [2]

Doctors in India have various barriers to accessing medical information from the Internet. Various studies have elaborated these barriers. Some of the studies we referred are by Thakker [8]; and Geyoushi and Stones.[9] The barriers and constraints include the following

a. Lack of time to browse for medical information
b. Individual economic hardship
c. Poor infrastructure
d. On duty / call most of the time
e. Population per physician is 1916 [7]

Looking into the cultural context, few countries in the world have such an ancient and diverse culture as India's. Stretching back in an unbroken sweep over 5000 years, India's culture has been enriched by successive waves of migration, which were absorbed into the Indian way of life. Internet is proving to be a very popular networking technology universally. The phenomenal advances in communications and information technology in India are resulting in a new look at how secondary and tertiary health care can be provided to the underprivileged masses. Following a proof of concept validation ISRO (Indian Space Research Organization) in conjunction with the Apollo Hospitals is ready to use satellite technology to provide specialist care not only to suburban and rural India but to other countries as well, by using the large number of highly qualified and trained specialists in urban India. [15]

On being aware of the above limitations to access medical information, we at Recon Healthcare Ltd, Bangalore, India initiated a system of sending the required information quickly and in a cost effective manner. This was done with an aim to spreading medical information to a large number

of doctors in urban and rural India. A model has been established towards this for the process of information dissemination. Two projects were taken and successfully completed. The following are the two projects.

PROJECT 1

Internet as a Tool to Procure and Spread Medical Information to Doctors in India

Data procured in the year 2002 reported that there are 7 million Internet users in India.[6] In this paper; the percentage of requests by doctors for medical information from the Internet has been compiled for the period July 01, 1998 to July 09, 2002. The doctors consisted of physicians, surgeons, medical students, and postgraduate trainees. Invariably, the information has been used by doctors to update medical care, emergency care, thesis / dissertation, publication of case reports, articles, and presentation of data.

From the data on file regarding medical queries from doctors we separated, medical information Internet requests from medical information non-internet requests.

Medical information from Internet was pertaining to diagnostic techniques, conference details, withdrawal of molecules, surgical techniques, guidelines for treatment, abstracts of clinical studies comprising of efficacy, safety, and tolerability, case reports and update on emergency care.

Exclusion criteria in this population were medical information not procured from Internet and inclusion criteria were medical information procured from the Internet. Two hundred seventy eight such requests were received. This data was compared with information sought from non-internet requests as procured from standard journals, textbooks, and from our literature on file.

Results and Discussion

Statistical analysis

Bar diagrams: Annual increase in number of Internet requests, Internet request from India, Internet request from South, West, East and North India, Internet vs. non- internet requests. Pie Chart: The percentage distribution of Internet requests split into 4 regions in India is brought out. The statistical analysis was done using the Student's 't'-test.

Results

In the bar diagram given below, the gradual increase in the number of requests is depicted. As seen there is an annual increase in number of requests (Fig. 1). The year 2002 is representative of requests until July 9, 2002.

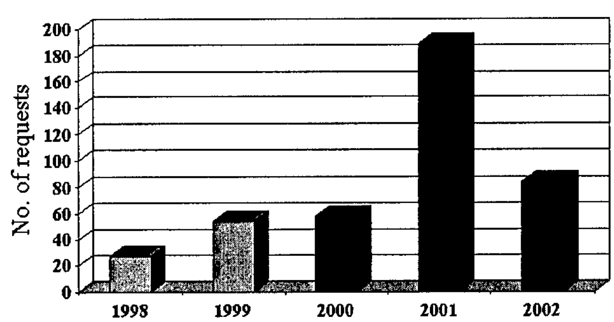

Fig 1 Annual increase in the number of requests

The number of requests was segregated based on the four zones – east, west, north and south. The percentage request is depicted in figure 2

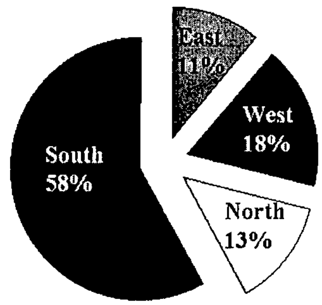

Fig 2 Percentage distribution of internet requests

Amongst the numbers of requests in the various cities- the following results appeared. We observed that the maximum requests were from metropolitan cities - Bangalore (131) followed by Mumbai (23) Kolkata (14) and Delhi (25).

An increasing trend in Internet requests was observed in this study. From the data on file, we compared the Internet requests with the non-internet and found that over a period of 4 years, there was an increasing trend in 2001.

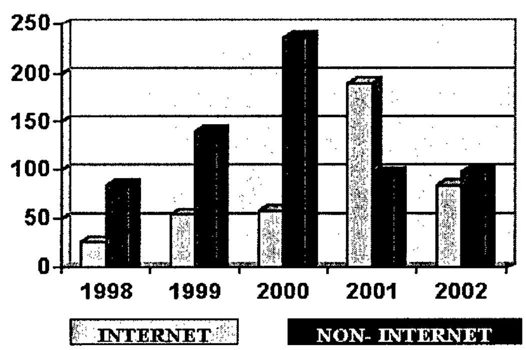

Fig 3 Internet Vs Non-internet requests

As shown in figure 3, while comparing non-internet requests with Internet requests through the years 1998, 1999, 2000, 2001, 2002, one is observing a very interesting trend. During the first 3 years non-internet requests were distinctly more than Internet requests and this was statistically significant for the year 1999 (p 0.05) and 2000 (p 0.005). From January 2001, the medical department sent regular e-mails to doctors informing of the Internet facility being made available

free of cost. It is clear that the above approach of doctors being contacted has paid its dividend in the form of more Internet requests coming up in the year 2001 and 2002 as shown in figure 4. Added to this, continuing medical education (CME) programs were conducted and at these programs the medical information services offered by us was informed to the doctors. Consequent to this, we saw a rise in the number of requests.

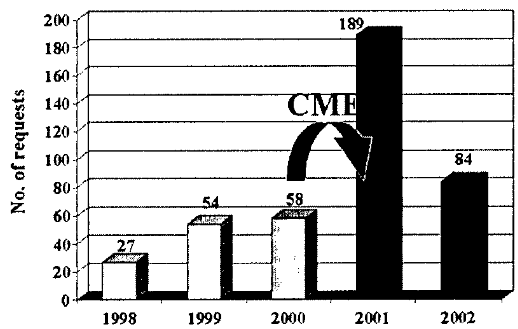

Fig 4 Increase in internet requests following CME

It has been our interest to assess the impact of continuing medical education in rural cities. For purposes of definition of rural, in this study we have defined rural, as that area where a large percentage of people are dependent upon agriculture for income and livelihood. We are aware; in today's world of globalization this might not be an appropriate criteria. For want of a better definition, we have taken this for our presentation.

Among the rural Indian cities, it was observed that Tumkur in Karnataka tops the list with 34 requests. This is a very encouraging trend and sure to add on to the knowledge of such doctors in the field of medicine where the developments are occurring in an explosive way.

In a publication on Internet usage among Mumbai, India training hospitals it was revealed that amongst 182 medical students interviewed, approximately 40% surfed the Internet. Of those using the Internet, only 15% surfed for medical information. Of the 180 medical interns

interviewed, at least 65% surfed the Internet. Of these, less than 25% used the Internet for medical information. Of the 106 resident doctors interviewed, almost 50% surfed the Internet. Of the 56 lecturers, only about 25% used the Internet to search for medical information. We would like to focus on the fact that of the 28 professionals, only about 25% found time to access the Internet on a fortnightly irregular basis. The above paper also informs us on the access to Internet knowledge by the students, interns, resident doctors, and lecturers in teaching hospitals in Mumbai and the inadequate usage of the same for furthering their knowledge.[8]

Geyoushi and Stones conducted a study to identify the constraints and facilitators to evidence based practice, participant's perception about these barriers and facilitators. Forty-one doctors (twenty-eight from India and thirteen from the Yemen) working in the field of reproductive healthcare, whether obstetrics and gynecology, general practice or family planning participated in this study.

Barriers towards implementing evidence into practice were lack of information sources such as libraries and the paucity of resources on hand as well as difficulties in access. Economic institutional constraints due to a poor infrastructure and some cultural restrictions were identified as well as lack of incentive and de-motivation due to an inbreed hierarchical system. Lack of time and individual economic hardships were also identified factors as well as irrelevance of some western technology. Potential facilitators included medical family networking, teaching commitments and medical societies as a method of information distribution. The most important of facilitators identified would be the free availability of information through the Information technology highway; the Internet, understanding and catering to the needs of developing countries.

There are many barriers and constraints in implementing evidence based reproductive healthcare in developing countries, whether on individual or institutional levels. Understanding these difficulties can aid in overcoming some of these barriers and offering practical solutions. Although the main problems revolve around economic and financial constraints, offering support from developed countries must go hand in hand with introducing, developing and maintaining a culture of evidence based practice and mentality. This is essential if any of the solutions are to work.[9]

Our communication in sharp contrast is focusing on the practicing doctors in urban and rural India. More than 90% of our requests are from practicing doctors. In the Thakkar study, the group had to access information themselves. However, in our study we received requests to access information for doctors. This difference can be explained by the fact that in the Thakkar study, residents reported few good facilities for accessing the Internet on campus, on call almost every other day, and had very little time to do more than check e-mails. No wonder a busy practicing doctor in urban and rural area would find impossible to spare his valuable time to browse the Internet for medical information. It is in this context that our communication assumes tremendous importance. We have shown that it is possible for us to directly communicate with the doctors at their doorsteps - such of those who have an Internet facility in their chamber or cyber café near their area of practice.[10, 11]

PROJECT 2

Recon Healthcare Bangalore Model in spreading information from World Health Organization Reproductive Healthcare Library (WHO-RHL) to Doctors in India

The WHO-RHL is one of the major sources of information pertaining to reproductive health care knowledge. It is the product of interaction between the WHO-RHL, research centers in developing countries and the Cochrane Collaboration. It is the first specialist database project for the Cochrane Collaboration, as well as for the WHO and has followed evidence-based medicine. The information is stored in the electronic form-diskettes and CD –ROM; and updated annually and is available free of cost to developing countries. [12]

The WHO RHL contains systematic reviews of controlled trials on priority reproductive health topics, expert commentaries on the relevance of the findings for developing countries, and practical advice on the management of reproductive health problems. The systematic reviews come from The Cochrane Library. The commentaries and practical advice are prepared by researchers from developing countries or by persons with extensive knowledge of the conditions and practice in those countries.

As this is in an electronic medium, one has to evolve methodologies by which this vast content of knowledge could be spread to doctors working in various parts of India – both rural and urban.[13] Those doctors in rural India and many parts of urban India do not have an easy access to this information. Therefore, it has become essential to come out with an effective system by which this could be done. Academia usually have enormous knowledge base without much of facility to disseminate this rapidly. Industry, on the other hand has facilities to communicate rapidly with

doctors through their marketing executives, and e-mail. The combination of these two organizations becomes an effective method to spread knowledge rapidly to doctors whenever needed. When done this turns out to be a good example of Academia-Industry Interaction (AII). Academia such as the WHO providing the knowledge base, and industry offering support for its dissemination. To the best of our knowledge, such an exercise of AII to spread medical knowledge in developing countries or developed countries has not been published.

Evidence based healthcare involves deriving questions from clinical problems searching systematically and thoroughly for best relevant evidence, critically appraising the evidence, and applying new knowledge in the clinical context. Although, most clinicians support the notion of evidence based healthcare in principle and wish to use this information generated by others, only a tiny fraction seek to acquire all the requisite skills themselves. A study in British General Practice found that the commonest reason sited for not practicing evidence-based healthcare was lack of time followed by personal and organizational inertia.[14]

Materials And Method

At Recon Healthcare, Bangalore the medical department has taken the initiative to spread the information in the WHO-RHL to doctors particularly gynecologists and obstetricians. This was done jointly with the marketing executives. Three topics were chosen from eighteen topics after a consensus amongst the non-medical executives of the organization.

- Routine antenatal care for low-risk pregnancy
- Routine iron and folate supplementation in pregnancy
- Episiotomy policies in vaginal birth

The titles were printed on a sheet and sent to 313 Business Officers of Recon Healthcare working all over India, with instruction to handover the format to gynecologists and obstetricians in their area. Each Business Officer received ten such formats. The doctors were requested to put down their preferences and handover to the officer who would mail it to the Bangalore office. Through this, we expected response from 3130 gynecologists and obstetricians would emerge.[11]

This study was initiated in the month of September 01, 2001 and as of March 31, 2002, 1346 doctors have responded and the faculty in medical department has received these forms. This is analyzed and presented in the communication.

Results

The overall response in the four regions of India was as follows: West 58.04%, North 51.21%, South 32.62% and East 44.29%. To get a feedback on the WHO-RHL information given to doctors the following questions were sent to the doctors (Personal communication. Dr. Vishwanath Anantraman, Harvard University, 2002)

Questions	**Answers (%)**	
	Yes	**No**
Did you receive the WHO-RHL Updates?	94	6
Was the write up useful?	88.87	7.13
Did this help you in improving patient care?	83.73	10.7
Was the information applied in your practice?	78.48	13.4

Would you like to share this knowledge with your other doctor colleagues?	58.32	34.6

DISCUSSION

This model worked out to be cost effective. The existing infrastructure being utilised for routine office work, was made use of for the model. The postal charges amounted to Rs. 32,520/=, stationery including cartridge and paper amounted to Rs. 29,500/=. Hence, the total amounts to Rs. 62,020/=. The expenditure incurred for disseminating medical information works out to Rs. 46 per doctor. So, this model is a cost effective one.

Postal & stationery	
Postal	Rs. 32,520
Stationery (cartridge & paper)	Rs. 29,500
Total	Rs. 62,020
In dollars In Rupees	$ ~1240 Rs. 46 per doctor

We have established a clear methodology by which knowledge could be disseminated, making use of the already existing facilities such as Microsoft Windows 98, CD ROM drive, and a printer. Thus, no additional expensive inputs have been brought into this. As we have established this as a model, we propose naming this Recon Healthcare Bangalore Model (RHBM) for disseminating medical knowledge to doctors in India.[15]

Following are the high points of RHBM:

- Making use of the available facility in the Corporate, which is used for other official work of the organisation.
- Interaction with doctors, which is an already existing exercise.
- To this has been added dissemination of WHO-RHL information.
- 1346 doctors have been serviced within a short period of 7 months at a cost of Rs. 46 per doctor.

It is not possible for us to compare this with any other data, as it is not yet available anywhere in developing countries. We are not aware of such data from a developed country either.

WHO-RHL information has been communicated to doctors across India. This is one of the primary objectives of WHO. Without any additional inputs, and with the methodology put down in the RHBM, it should be possible for the Academia -Industry to interact and spread the knowledge of WHO-RHL to a very large number of doctors in India within the shortest possible time. Our model has demonstrated that this is possible. Thus, making use of the already existing information technology in our country, we should be able to improve the standards of healthcare all over India. Similar models could be evolved to spread the health knowledge in other developing countries in all spheres of health knowledge.[13]

USEFULNESS OF E-HEALTH IN INDIA

E-health to be really useful in India would mean to reach the rural areas rather than merely enhancing the facilities of those who already have better means of obtaining medical services. If

it is merely going to serve the needs of a few rich patients in cities like New Delhi and Mumbai, it will have little relevance. This is not to say that these segments should not have these facilities, but only to underline that they already have such facilities available and they could afford to have video conferencing not only within the country, but also even with the best of super specialists in any other part of the world.

Infrastructure: Certain amount of infrastructure/facilities is pre-requisites of e-health program. These include: minimal availability of

- Medical/Para-medical staff
- Electricity
- Communication lines like telephone
- Clinical investigation facilities

Looking at the Indian conditions, if you look for a place with this minimal infrastructure, one also sees that there are doctors available. In other places you have neither doctor nor the infrastructure and facilities. This creates a peculiar condition. Efforts have to be made to overcome this contrasting situation.

Some hospitals, either government, private or charitable trust owned, is available in any district town. A reasonable number of medical staff and associated medical facilities are also available in these towns. So telemedicine facilities (patient end) will have to be created in such district towns. Patients from the nearby villages visit these hospitals also. These patients end can be linked to super specialist end in any other part of the country/world (where the best of doctors would be available) and interaction can be established between these two ends. Telemedicine can be expensive in the initial stages, but over a period of time as the technologies develop, the human power gets used to using these facilities, the cost will gradually decrease [16].

In a study it was found that an e-mail link with the facility to send high-resolution digital images is a cheap and uncomplicated telemedicine method. The Swinfen Charitable Trust helped establish such a link in Patan Hospital Kathmandu, Nepal in March 2000. Over 12 months using these links, 42 telemedicine referrals were sent to specialists throughout the world. Referrals were: 36% respiratory medicine; 21% neurology, 21% dermatology; 14% cardiology; 5% nephrology; and 3% radiology--28 had digital pictures attached, of which 96% were of high enough quality on which specialists were able to comment. Thirty-nine replies were received. The average time for a specialist reply was 2 days, and 45% were answered within 24 hours. All replies were judged by independent assessors to be helpful or very helpful for diagnosis, management, and education. The assessors decided that in 50% of cases the advice if acted upon would have shortened hospital stay. This pilot study has shown that a low-cost telemedicine link is technically feasible and can be of significant benefit for diagnosis, management, and education in a developing world setting. [17]

There are super specialty hospitals where telemedicine facilities are available and functioning very well. A few examples have been incorporated. No doubt, the benefits of technology are well known and acceptance is also good. Linking up to rural sectors is also progressing.

What interventions are appropriate to change the cultures for a successful program?

Web based telemedicine solutions are gaining popularity owing to Internet's low cost and almost universal availability.[18] Internet is proving to be a very popular networking technology universally.

The development of the information superhighway presents a problem that will affect every person globally. This study explores how cultural and historical differences in countries influenced by British imperialism affect their integration into the global information infrastructure. Hofstede's models of cultural differences that define teaching and learning within an international culture are used as a theoretical framework to analyze data. The research strategy sampled electronically, explored, observed, and drew conclusions in the light of the country's history and culture. As information technology expands into a culture, elementary schools would be the last to be integrated. Forty-one of 156 elementary web sites formed the Australian sample population. In India, the search reached the technical school and college level before encountering the infrastructure. Historical and cultural explanations were explored for answers to the great disparity between the "haves" and "have-nots" in this country. There was evidence of a correlation between Hofstede's model of cultural differences and the growth of informational technology within Australia and India. Future implications of this framework would be to test whether Hofstede's model consistently correlates to integrating informational technology in other countries. Integrating technology worldwide might be improved by considering differences in cultural learning characteristics within a country.[19]

Success stories in Telemedicine
Gujarat: The Online Telemedicine Research Institute (OTRI) provided telemedicine links for teleconsultation, thereby establishing 750 sessions in a period of 30 days in Bhuj after the earthquake in January 2001. **Uttar Pradesh:** During the Kumbh Mela festival held every 12 years, which drew over 25 million pilgrims to the banks of river Ganga, the OTRI transferred data (cardiology and radiology data) of over 200 ailing pilgrims, besides sending microscope images of microorganisms to monitor levels of cholera-causing bacteria in the river.

Bangalore: Asia Heart Foundation has successfully been practicing Telecardiology between Bangalore and cities in eastern India. Paramedics are guided to save the patients suffering from Acute Myocardial Infarction by performing life-saving procedures as per directions from doctors over video conferencing.

Chennai: Apollo is providing expert opinion from its tertiary level hospitals in bigger cities to those in the far-flung towns of India. In the period of around 27 months at Apollo over 4,000 patients had been benefited through teleconsultations and over 75 percent of those teleconsulted were treated in their respective cities. [20]

Are there core values that make the adoption of telemedicine successful?

The drivers for adoption of telemedicine could vary from country to country based on various factors. Some of the factors that would expedite the telemedicine revolution in India are:

Topography: Think of a patient in Tinsukiya, Assam or Aragonda, Andhra Pradesh who requires a consultation with a specialist at Bangalore or Mumbai. The cost of travel and the travel it self could be a deterrent to the poor patient in these rural settings. Even if a specialist were available at the nearest town, reaching the interiors of such a far-flung village would be a challenge. This is where telemedicine could be utilized as an effective medium for healthcare delivery. India with a diverse collection of landscapes with mountains and valleys and high altitudes, telemedicine could well be a boon for the patients.

Travel time/ cost: There is a shortage of specialist/ super-specialist professionals in India, especially in rural areas. It might not be good time management on the part of the specialist to travel all the way to the rural areas without having enough patients to be attended to there. Travel

time can be cut down dramatically while the expertise is made available in real time via technology. The specialist's physical presence becomes necessary only when a surgical procedure is planned. In reality even surgical procedures are being conducted with guidance from the specialist who is at a remote location. For a patient cost of travel is a major worry especially if she has to fly in to a specialist care center in a city.

Pressure to reduce costs: Cost of healthcare and questions on who will bear the burden of care are issues across the world, developed countries included. The incidental expenses related to patient care, i.e. the cost associated with factors other than the actual medial care such as travel, accommodation for relatives, food etc also contribute substantially to the cost of treatment. In a country where health insurance is yet to catch up, cost of acre is borne by patients, in many cases by selling property and livestock. If hospitals can reduce these costs associated with treatment it would go a long way in reducing the burden of care on the patient. Telemedicine seems to be the answer. [21]

Given the scarcity of medical facilities in rural areas, efforts will have to be made to take this technology to rural areas. There will have to be a planned intervention programme dedicated to this end. Development and Educational Communication Unit (DECU) of Indian Space Research Organisation (ISRO) is now trying to set up a need based telemedicine project in different parts of the country. ISRO has recently initiated a GRAMSAT ('satellite for villages') programme. It is aimed at reaching out to the villages for development and educational purposes. A variety of satellite-based technologies/applications will be used for this purpose. [2]

In a study done during an 18-month study period, teleconsultations were conducted by email between a neonatal intensive care unit at an urban teaching hospital in western India and a rural primary care centre 40 km away. There were email consultations about 182 newborn babies; these consultations comprised 309 messages sent from the primary care centre and 272 messages

from the teaching hospital. The average reply time was 11.3 h. Thirty-eight babies were referred to the intensive care unit at the teaching hospital after these consultations. The remaining 144 babies were managed at the primary care centre. Telemedicine helped in the diagnosis, referral, treatment, and follow-up of patients. The cost of the email service was estimated to be Rs 12,000 and the savings in avoided transfer were estimated to be Rs 546,000, a cost-benefit ratio of 1:45.[22]

CONCLUSION

This chapter highlights our attempt to improve spread of health information in the area of healthcare in rural and urban India. Our country with its diverse culture, large population, definitely has to increasingly look into such technologies to acquire and spread knowledge in health field very rapidly. Adequate infrastructure facilities are available in our country. It is a question of channelling this in a proper direction by establishing methods to disseminate health knowledge into rural and urban India. One has to establish models to do this. We have worked towards establishing a model called Recon Healthcare Bangalore Model. Without incurring additional expenditure the existing infrastructure was effectively harnessed and a good cost effective model established. Developing countries must get interested in establishing such models. If done the world will definitely move one step forward in ultimately improving the healthcare facilities very rapidly.

A practicing doctor in rural India does not have the access to Internet and a doctor in urban India does not have the time to access Internet due to his practice. Due to these constraints, doctors appreciate the information provided to them on their request. By this, we understand that doctors are definitely interested in getting the latest information to update their knowledge base.

With the increasing availability of Internet facility and usage, one is confident that the medical knowledge of doctors at all levels can be enhanced very quickly. This confidence stems from the

fact that our trend analysis over the years show that there is an increasing need for up-to date medical information as evidenced by the increase in the number of requests. Necessarily, such a rapid transmission of knowledge especially to doctors in rural areas will be of great benefit towards patient care. Industry by directly communicating with the doctor as a part of their service and commitment to patient care can make a very significant contribution in building up their knowledge base and apply the same to patient care.

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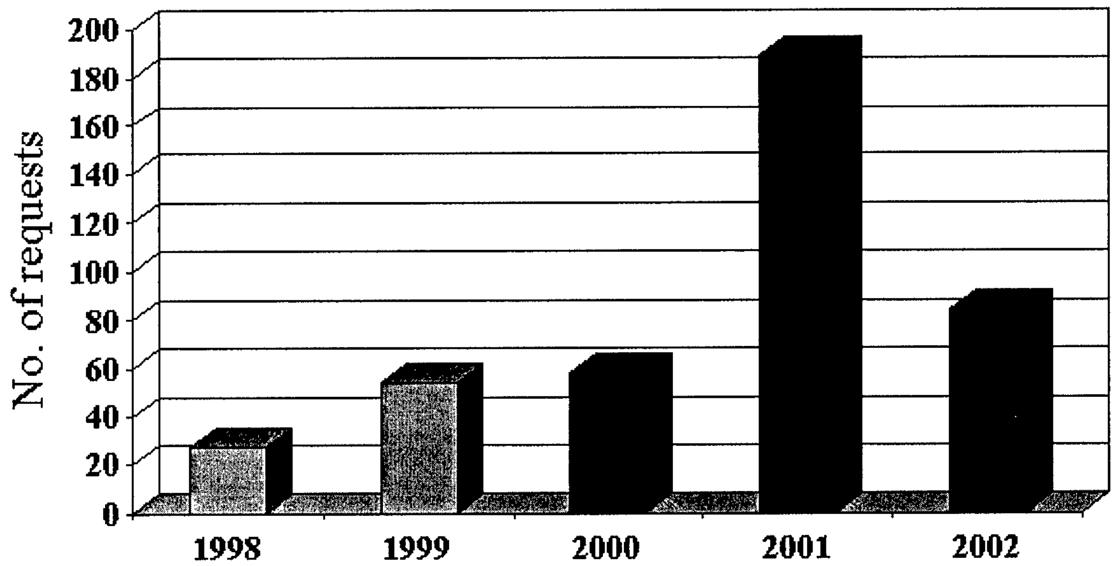

Fig 1 Annual increase in the number of requests

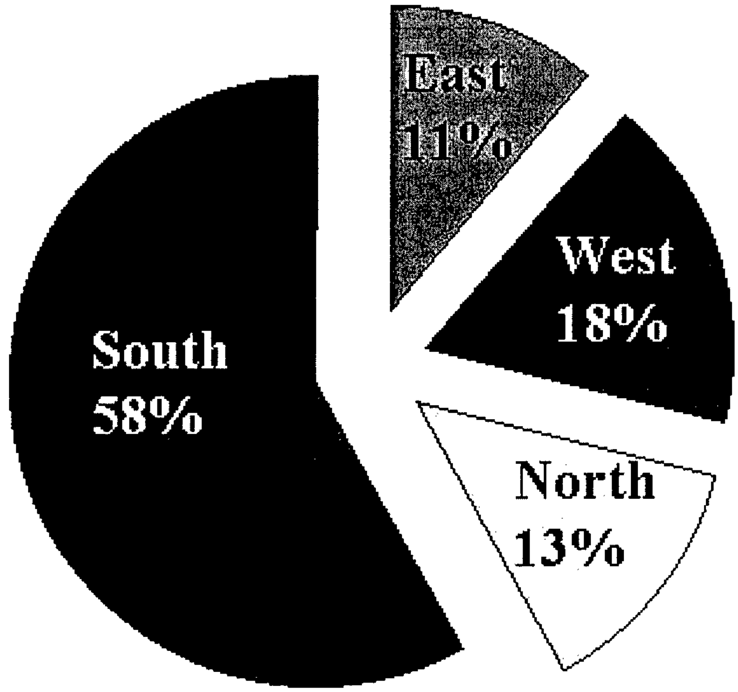

Fig 2 Percentage distribution of internet requests

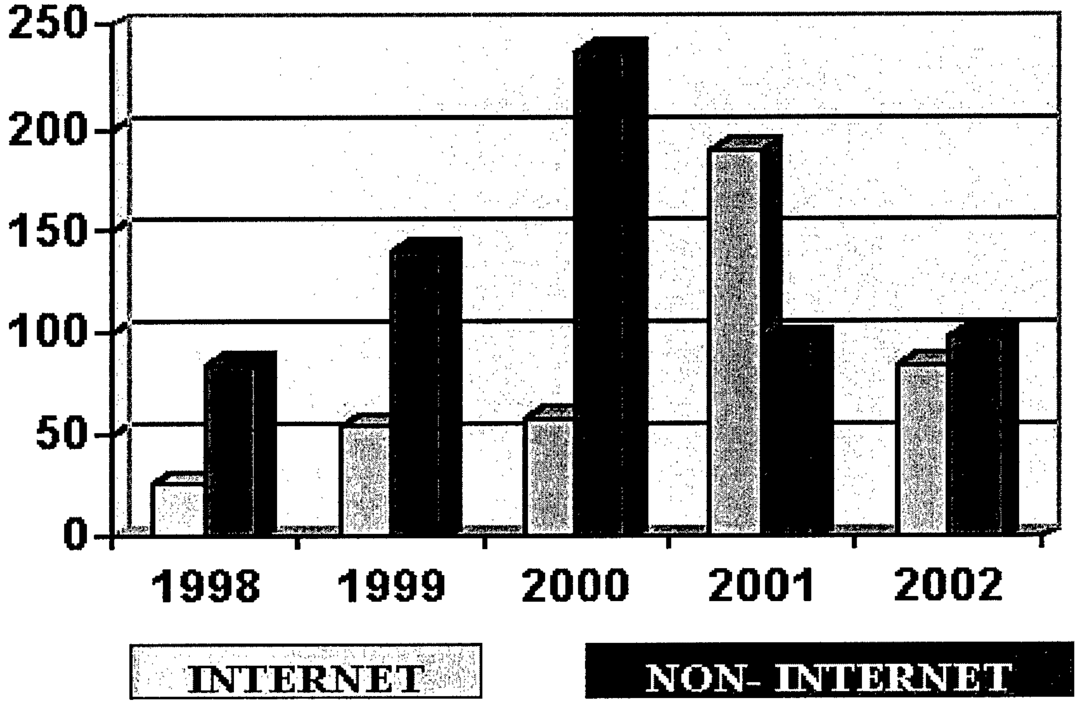

Fig 3 Internet Vs Non-internet requests

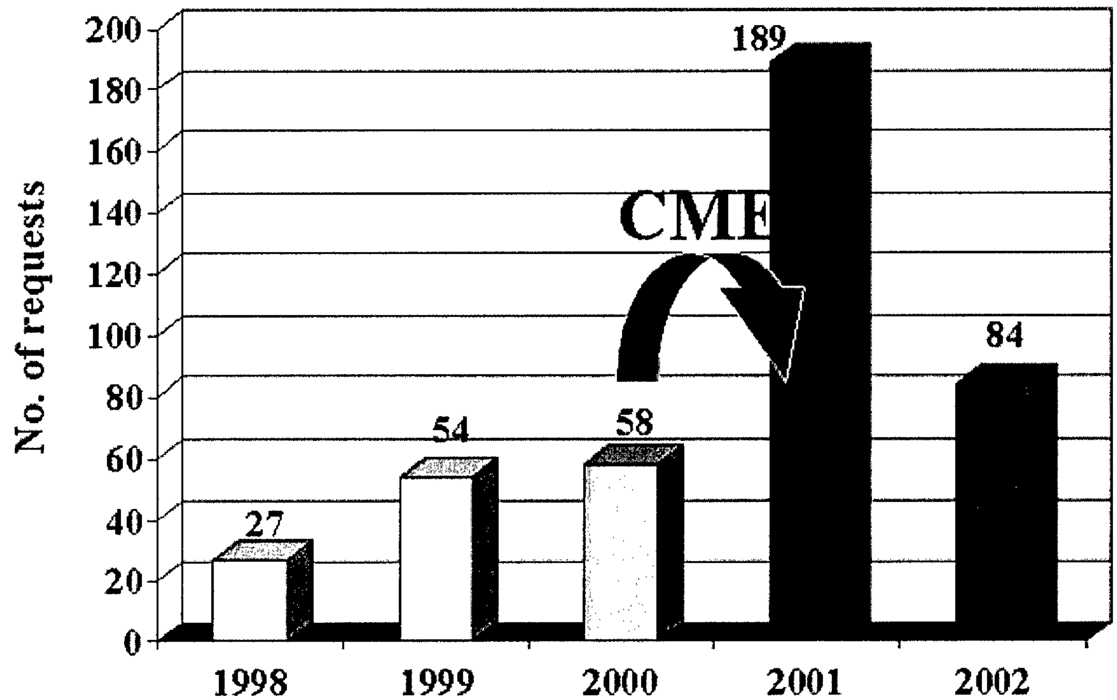

Fig 4 Increase in internet requests following CME

From: "Academy of Management Archive Site" <EPArchiver@epnet.com>
To: <mvaldez@cba.hawaii.edu>
Subject: **hofstede**
Date sent: Mon, 26 Jan 2004 18:53:20 -0500

Record: 1.

Title: Cultural constraints in management theories.
Subject: INDUSTRIAL management -- Cross-cultural studies
Author(s): Hofstede, Geert
Source: Academy of Management Executive,Feb93, Vol. 7 Issue 1, p81, 14p,
1
chart
Abstract: Studies cultural constraints in management practices and theories from different contexts and histories of places in the world. Categorization of national cultures according to five independent dimensions; Relative position of the United States and other countries; Theories at the national level.
AN: 9409142061
ISSN: 1079-5545

CULTURAL CONSTRAINTS IN MANAGEMENT THEORIES

Executive Overview Management as the word is presently used is an American invention. In other parts of the world not only the practices but
the entire concept of management may differ, and the theories needed to understand it, may deviate considerably from what is considered normal and
desirable in the USA. The reader is invited on a trip around the world, and both local management practices and theories are explained from the different contexts and histories of the places visited: Germany, Japan, France, Holland, the countries of the overseas Chinese, South-East Asia, Africa, Russia, and finally mainland China.

A model in which worldwide differences in national cultures are categorized according to five independent dimensions helps in explaining the differences in management found; although the situation in each country or region has unique characteristics that no model can account for. One practical application of the model is in demonstrating the relative position of the U.S. versus other parts of the world. In a global
perspective, U.S. management theories contain a number of idiosyncracies not necessarily shared by management elsewhere. Three such idiosyncracies
are mentioned: a stress on market processes, a stress on the individual, and a focus on managers rather than on workers. A plea is made for an internationalization not only of business, but also of management theories, as a way of enriching theories at the national level.

In My View Lewis Carroll's Alice in Wonderland contains the famous

story
of Alice's croquet game with the Queen of Hearts.

Alice thought she had never seen such a curious croquet-ground in all her
life; it was all ridges and furrows; the balls were live hedgehogs, the mallets live flamingoes, and the soldiers had to double themselves up and
to stand on their hands and feet, to make the arches.

You probably know how the story goes: Alice's flamingo mallet turns its head whenever she wants to strike with it; her hedgehog ball runs away; and the doubled-up soldier arches walk around all the time. The only rule
seems to be that the Queen of Hearts always wins.

Alice's croquet playing problems are good analogies to attempts to build culture-free theories of management. Concepts available for this purpose are themselves alive with culture, having been developed within a particular cultural context. They have a tendency to guide our thinking toward our desired conclusion.

As the same reasoning may also be applied to the arguments in this article, I better tell you my conclusion before I continue--so that the rules of my game are understood. In this article we take a trip around the
world to demonstrate that there are no such things as universal management
theories.

Diversity in management practices as we go around the world has been recognized in U.S. management literature for more than thirty years. The term "comparative management" has been used since the 1960s. However, it has taken much longer for the U.S. academic community to accept that not only practices but also the validity of theories may stop at national borders, and I wonder whether even today everybody would agree with this statement.

An article I published in Organizational Dynamics in 1980 entitled "Do American Theories Apply Abroad?" created more controversy than I expected.
The article argued, with empirical support, that generally accepted U.S. theories like those of Maslow, Herzberg, McClelland, Vroom, McGregor, Likert, Blake and Mouton may not or only very partly apply outside the borders of their country of origin--assuming they do apply within those borders. Among the requests for reprints, a larger number were from Canada
than from the United States.

Management Theorists are Human Employees and managers are human. Employees as humans was "discovered" in the 1930s, with the Human Relations school. Managers as humans, was introduced in the late 40s by Herbert Simon's "bounded rationality" and elaborated in Richard Cyert and

James March's Behavioral Theory of the Firm (1963,and recently re-published in a second edition). My argument is that management scientists, theorists, and writers are human too: they grew up in a particular society in a particular period, and their ideas cannot help but reflect the constraints of their environment.

The idea that the validity of a theory is constrained by national borders is more obvious in Europe, with all its borders, than in a huge borderless country like the U.S. Already in the sixteenth century Michel de Montaigne, a Frenchman, wrote a statement which was made famous by Blaise Pascal about a century later: "Verite en-deca des Pyrenees, erreur au-dela"--There are truths on this side of the Pyrenees which are falsehoods on the other.

From Don Armado's Love to Taylor's Science According to the comprehensive ten-volume Oxford English Dictionary (1971), the words "manage," "management," and "manager" appeared in the English language in the 16th century. The oldest recorded use of the word "manager" is in Shakespeare's "Love's Labour's Lost," dating from 1588, in which Don Adriano de Armado, "a fantastical Spaniard," exclaims (Act I, scene ii, 188):

"Adieu, valour! rust, rapier! be still, drum! for your manager is in love; yea, he loveth".

The linguistic origin of the word is from Latin manus, hand, via the Italian maneggiare, which is the training of horses in the manege; subsequently its meaning was extended to skillful handling in general, like of arms and musical instruments, as Don Armado illustrates. However, the word also became associated with the French menage, household, as an equivalent of "husbandry" in its sense of the art of running a household.
The theatre of present-day management contains elements of both manege and menage and different managers and cultures may use different accents.

The founder of the science of economics, the Scot Adam Smith, in his 1776 book The Wealth of Nations, used "manage," "management" (even "bad management") and "manager" when dealing with the process and the persons involved in operating joint stock companies (Smith, V.i.e.). British economist John Stuart Mill (1806-1873) followed Smith in this use and clearly expressed his distrust of such hired people who were not driven by ownership. Since the 1880s the word "management" appeared occasionally in

writings by American engineers, until it was canonized as a modern science
by Frederick W. Taylor in Shop Management in 1903 and in The Principles of
Scientific Management in 1911.

While Smith and Mill used "management" to describe a process and "managers" for the persons involved, "management" in the American sense--which has since been taken back by the British--refers not only to
the process but also to the managers as a class of people. This class () does not own a business but sells its skills to act on behalf of the owners and () does not produce personally but is indispensable for making
others produce, through motivation. Members of this class carry a high status and many American boys and girls aspire to the role. In the U.S., the manager is a cultural hero.

Let us now turn to other parts of the world. We will look at management in
its context in other successful modern economies: Germany, Japan, France,
Holland, and among the Overseas Chinese. Then we will examine management in the much larger part of the world that is still poor, especially South-East Asia and Africa, and in the new political configurations of Eastern Europe, and Russia in particular. We will then return to the U.S.
via mainland China.

Germany

The manager is not a cultural hero in Germany. If anybody, it is the engineer who fills the hero role. Frederick Taylor's Scientific Management
was conceived in a society of immigrants--where large number of workers with diverse backgrounds and skills had to work together. In Germany this
heterogeneity never existed.

Elements of the mediaeval guild system have survived in historical continuity in Germany until the present day. In particular, a very effective apprenticeship system exists both on the shop floor and in the office, which alternates practical work and classroom courses. At the end
of the apprenticeship the worker receives a certificate, the Facharbeiterbrief, which is recognized throughout the country. About two thirds of the German worker population holds such a certificate and a corresponding occupational pride. In fact, quite a few German company presidents have worked their way up from the ranks through an apprenticeship. In comparison, two thirds of the worker population in Britain have no occupational qualification at all.

The highly skilled and responsible German workers do not necessarily need

a manager, American-style, to "motivate" them. They expect their boss or Meister to assign their tasks and to be the expert in resolving technical problems. Comparisons of similar German, British, and French organizations show the Germans as having the highest rate of personnel in productive roles and the lowest both in leadership and staff roles.

Business schools are virtually unknown in Germany. Native German management theories concentrate on formal systems. The inapplicability of American concepts of management was quite apparent in 1973 when the U.S. consulting firm of Booz, Allen and Hamilton, commissioned by the German Ministry of Economic Affairs, wrote a study of German management from an American view point. The report is highly critical and writes among other things that "Germans simply do not have a very strong concept of management." Since 1973, from my personal experience, the situation has not changed much. However, during this period the German economy has performed in a superior fashion to the U.S. in virtually all respects, so a strong concept of management might have been a liability rather than an asset.

Japan

The American type of manager is also missing in Japan. In the United States, the core of the enterprise is the managerial class. The core of the Japanese enterprise is the permanent worker group; workers who for all practical purposes are tenured and who aspire at life-long employment. They are distinct from the non-permanent employees--most women and subcontracted teams led by gang bosses, to be laid off in slack periods. University graduates in Japan first join the permanent worker group and subsequently fill various positions, moving from line to staff as the need occurs while paid according to seniority rather than position. They take part in Japanese-style group consultation sessions for important decisions, which extend the decision-making period but guarantee fast implementation afterwards. Japanese are to a large extent controlled by their peer group rather than by their manager.

Three researchers from the East-West Center of the University of Hawaii, Joseph Tobin, David Wu, and Dana Danielson, did an observation study of typical preschools in three countries: China, Japan, and the United States. Their results have been published both as a book and as a video. In the Japanese preschool, one teacher handled twenty-eight four-year olds. The video shows one particularly obnoxious boy, Hiroki, who fights with other children and throws teaching materials down from the balcony. When a little girl tries to alarm the teacher, the latter answers "what are you calling me for? Do something about it!" In the U.S. preschool, there is one adult for every nine children. This class has its problem child too, Glen, who refuses to clear away his toys. One of the teachers

has a long talk with him and isolates him in a corner, until he changes his mind. It doesn't take much imagination to realize that managing Hiroki thirty years later will be a different process from managing Glen.

American theories of leadership are ill-suited for the Japanese group-controlled situation. During the past two decades, the Japanese have developed their own "PM" theory of leadership, in which P stands for performance and M for maintenance. The latter is less a concern for individual employees than for maintaining social stability. In view of the amazing success of the Japanese economy in the past thirty years, many Americans have sought for the secrets of Japanese management hoping to copy them.

There are no secrets of Japanese management, however; it is even doubtful whether there is such a thing as management, in the American sense, in Japan at all. The secret is in Japanese society; and if any group in society should be singled out as carriers of the secret, it is the workers, not the managers.

France

The manager, U.S. style, does not exist in France either. In a very enlightening book, unfortunately not yet translated into English, the French researcher Philippe d'Iribarne (1989) describes the results of in-depth observation and interview studies of management methods in three subsidiary plants of the same French multinational: in France, the United States, and Holland. He relates what he finds to information about the three societies in general. Where necessary, he goes back in history to trace the roots of the strikingly different behaviors in the completion of the same tasks. He identifies three kinds of basic principles (logiques) of management. In the USA, the principle is the fair contract between employer and employee, which gives the manager considerable prerogatives, but within its limits. This is really a labor market in which the worker sells his or her labor for a price. In France, the principle is the honor of each class in a society which has always been and remains extremely stratified, in which superiors behave as superior beings and subordinates accept and expect this, conscious of their own lower level in the national hierarchy but also of the honor of their own class. The French do not think in terms of managers versus nonmanagers but in terms of cadres versus non-cadres; one becomes cadre by attending the proper schools and one remains it forever; regardless of their actual task, cadres have the privileges of a higher social class, and it is very rare for a non-cadre to cross the ranks.

The conflict between French and American theories of management became apparent in the beginning of the twentieth century, in a criticism by the great French management pioneer Henri Fayol (1841-1925) on his U.S. colleague and contemporary Frederick W. Taylor (1856-1915). The difference in career paths of the two men is striking. Fayol was a French engineer whose career as a cadre superieur culminated in the position of President-Directeur-General of a mining company. After his retirement he formulated his experiences in a pathbreaking text on organization: Administration industrielle et generale, in which he focussed on the sources of authority. Taylor was an American engineer who started his career in industry as a worker and attained his academic qualifications through evening studies. From chief engineer in a steel company he became one of the first management consultants. Taylor was not really concerned with the issue of authority at all; his focus was on efficiency. He proposed to split the task of the first-line boss into eight specialisms, each exercised by a different person; an idea which eventually led to the idea of a matrix organization.

Taylor's work appeared in a French translation in 1913, and Fayol read it and showed himself generally impressed but shocked by Taylor's "denial of the principle of the Unity of Command" in the case of the eight-boss-system.

Seventy years later Andre Laurent, another of Fayol's compatriots, found that French managers in a survey reacted very strongly against a suggestion that one employee could report to two different bosses, while U.S. managers in the same survey showed fewer misgivings. Matrix organization has never become popular in France as it has in the United States.

Holland

In my own country, Holland or as it is officially called, the Netherlands, the study by Philippe d'Iribarne found the management principle to be a need for consensus among all parties, neither predetermined by a contractual relationship nor by class distinctions, but based on an open-ended exchange of views and a balancing of interests. In terms of the different origins of the word "manager," the organization in Holland is more menage (household) while in the United States it is more manege (horse drill).

At my university, the University of Limburg at Maastricht, every semester we receive a class of American business students who take a program in

European Studies. We asked both the Americans and a matched group of Dutch students to describe their ideal job after graduation, using a list of twenty-two job characteristics. The Americans attached significantly more importance than the Dutch to earnings, advancement, benefits, a good working relationship with their boss, and security of employment. The Dutch attached more importance to freedom to adopt their own approach to the job, being consulted by their boss in his or her decisions, training opportunities, contributing to the success of their organization, fully using their skills and abilities, and helping others. This list confirms d'Iribarne's findings of a contractual employment relationship in the United States, based on earnings and career opportunities, against a consensual relationship in Holland. The latter has centuries-old roots; the Netherlands were the first republic in Western Europe (1609-1810), and a model for the American republic. The country has been and still is governed by a careful balancing of interests in a multi-party system.

In terms of management theories, both motivation and leadership in Holland are different from what they are in the United States. Leadership in Holland presupposes modesty, as opposed to assertiveness in the United States. No U.S. leadership theory has room for that. Working in Holland is not a constant feast, however. There is a built-in premium on mediocrity and jealousy, as well as time-consuming ritual consultations to maintain the apparence of consensus and the pretense of modesty. There is unfortunately another side to every coin.

The overseas Chinese

Among the champions of economic development in the past thirty years we find three countries mainly populated by Chinese living outside the Chinese mainland: Taiwan, Hong Kong and Singapore. Moreover, overseas Chinese play a very important role in the economies of Indonesia, Malaysia, the Philippines and Thailand, where they form an ethnic minority. If anything, the little dragons--Taiwan, Hong Kong and Singapore--have been more economically successful than Japan, moving from rags to riches and now counted among the world's wealthy industrial countries. Yet very little attention has been paid to the way in which their enterprises have been managed. The Spirit of Chinese Capitalism by Gordon Redding (1990), the British dean of the Hong Kong Business School, is an excellent book about Chinese business. He bases his insights on personal acquaintance and in-depth discussions with a large number of overseas Chinese businesspeople.

Overseas Chinese American enterprises lack almost all characteristics of modern management. They tend to be small, cooperating for essential functions with other small organizations through networks based on personal relations. They are family-owned, without the separation between

ownership and management typical in the West, or even in Japan and Korea.
They normally focus on one product or market, with growth by opportunistic
diversification; in this, they are extremely flexible. Decision making is
centralized in the hands of one dominant family member, but other family members may be given new ventures to try their skills on. They are low-profile and extremely cost-conscious, applying Confucian virtues of thrift and persistence. Their size is kept small by the assumed lack of loyalty of non-family employees, who, if they are any good, will just wait
and save until they can start their own family business.

Overseas Chinese prefer economic activities in which great gains can be made with little manpower, like commodity trading and real estate. They employ few professional managers, except their sons and sometimes daughters who have been sent to prestigious business schools abroad, but who upon return continue to run the family business the Chinese way.

The origin of this system, or--in the Western view--this lack of system, is found in the history of Chinese society, in which there were no formal
laws, only formal networks of powerful people guided by general principles
of Confucian virtue. The favors of the authorities could change daily, so
nobody could be trusted except one's kinfolk--of whom, fortunately, there
used to be many, in an extended family structure. The overseas Chinese way
of doing business is also very well adapted to their position in the countries in which they form ethnic minorities, often envied and threatened by ethnic violence.

Overseas Chinese businesses following this unprofessional approach command
a collective gross national product of some 200 to 300 billion US dollars,
exceeding the GNP of Australia. There is no denying that it works.

Management Transfer to Poor Countries Four-fifths of the world population
live in countries that are not rich but poor. After World War II and decolonization, the stated purpose of the United Nations and the World Bank has been to promote the development of all the world's countries in a
war on poverty. After forty years it looks very much like we are losing this war. If one thing has become clear, it is that the export of Western--mostly American--management practices and theories to poor countries has contributed little to nothing to their development. There has been no lack of effort and money spent for this purpose: students from
poor countries have been trained in this country, and teachers and Peace

Corps workers have been sent to the poor countries. If nothing else, the general lack of success in economic development of other countries should be sufficient argument to doubt the validity of Western management theories in non-Western environments.

If we examine different parts of the world, the development picture is not equally bleak, and history is often a better predictor than economic factors for what happens today. There is a broad regional pecking order with East Asia leading. The little dragons have passed into the camp of the wealthy; then follow South-East Asia (with its overseas Chinese minorities), Latin America (in spite of the debt crisis), South Asia, and Africa always trails behind. Several African countries have only become poorer since decolonization.

Regions of the world with a history of large-scale political integration and civilization generally have done better than regions in which no large-scale political and cultural infrastructure existed, even if the old civilations had decayed or been suppressed by colonizers. It has become painfully clear that development cannot be pressure-cooked; it presumes a cultural infrastructure that takes time to grow. Local management is part of this infrastructure; it cannot be imported in package form. Assuming that with so-called modern management techniques and theories outsiders can develop a country has proven a deplorable arrogance. At best, one can hope for a dialogue between equals with the locals, in which the Western partner acts as the expert in Western technology and the local partner as the expert in local culture, habits, and feelings.

Russia and China

The crumbling of the former Eastern bloc has left us with a scattering of states and would-be states of which the political and economic future is extremely uncertain. The best predictions are those based on a knowledge of history, because historical trends have taken revenge on the arrogance of the Soviet rulers who believed they could turn them around by brute power. One obvious fact is that the former bloc is extremely heterogeneous, including countries traditionally closely linked with the West by trade and travel, like Czechia, Hungary, Slovenia, and the Baltic states, as well as others with a Byzantine or Turkish past; some having been prosperous, others always extremely poor.

The industrialized Western world and the World Bank seem committed to helping the ex-Eastern bloc countries develop, but with the same technocratic neglect for local cultural factors that proved so

unsuccessful in the development assistance to other poor countries. Free market capitalism, introduced by Western-style management, is supposed to
be the answer from Albania to Russia.

Let me limit myself to the Russian republic, a huge territory with some 140 million inhabitants, mainly Russians. We know quite a bit about the Russians as their country was a world power for several hundreds of year before communism, and in the nineteenth century it has produced some of the greatest writers in world literature. If I want to understand the Russians--including how they could so long support the Soviet regime--I tend to re-read Lev Nikolayevich Tolstoy. In his most famous novel Anna Karenina (1876) one of the main characters is a landowner, Levin, whom Tolstoy uses to express his own views and convictions about his people. Russian peasants used to be serfs; serfdom had been abolished in 1861, but
the peasants, now tenants, remained as passive as before. Levin wanted to
break this passivity by dividing the land among his peasants in exchange for a share of the crops; but the peasants only let the land deteriorate further. Here follows a quote:

"(Levin) read political economy and socialistic works . . . but, as he had
expected, found nothing in them related to his undertaking. In the political economy books--in (John Stuart) Mill, for instance, whom he studied first and with great ardour, hoping every minute to find an answer
to the questions that were engrossing him--he found only certain laws deduced from the state of agriculture in Europe; but he could not for the
life of him see why these laws, which did not apply to Russia, should be considered universal. . . . Political economy told him that the laws by which Europe had developed and was developing her wealth were universal and absolute. Socialist teaching told him that development along those lines leads to ruin. And neither of them offered the smallest enlightenment as to what he, Levin, and all the Russian peasants and landowners were to do with their millions of hands and millions of acres,
to make them as productive as possible for the common good."

In the summer of 1991, the Russian lands yielded a record harvest, but a large share of it rotted in the fields because no people were to be found
for harvesting. The passivity is still there, and not only among the peasants. And the heirs of John Stuart Mill (whom we met before as one of
the early analysts of "management") again present their universal recipes
which simply do not apply.

Citing Tolstoy, I implicitly suggest that management theorists cannot neglect the great literature of the countries they want their ideas to apply to. The greatest novel in the Chinese literature is considered Cao

Xueqin's The Story of the Stone, also known as The Dream of the Red Chamber which appeared around 1760. It describes the rise and fall of two
branches of an aristocratic family in Beijing, who live in adjacent plots
in the capital. Their plots are joined by a magnificent garden with several pavillions in it, and the young, mostly female members of both families are allowed to live in them. One day the management of the garden
is taken over by a young woman, Tan-Chun, who states:

"I think we ought to pick out a few experienced trust-worthy old women from among the ones who work in the Garden--women who know something about
gardening already--and put the upkeep of the Garden into their hands. We needn't ask them to pay us rent; all we need ask them for is an annual share of the produce. There would be four advantages in this arrangement.
In the first place, if we have people whose sole occupation is to look after trees and flowers and so on, the condition of the Garden will improve gradually year after year and there will be no more of those long
periods of neglect followed by bursts of feverish activity when things have been allowed to get out of hand. Secondly there won't be the spoiling
and wastage we get at present. Thirdly the women themselves will gain a little extra to add to their incomes which will compensate them for the hard work they put in throughout the year. And fourthly, there's no reason
why we shouldn't use the money we should otherwise have spent on nurserymen, rockery specialists, horticultural cleaners and so on for other purposes."

As the story goes on, the capitalist privatization--because that is what it is--of the Garden is carried through, and it works. When in the 1980s Deng Xiaoping allowed privatization in the Chinese villages, it also worked. It worked so well that its effects started to be felt in politics
and threatened the existing political order; hence the knockdown at Tienanmen Square of June 1989. But it seems that the forces of privatization are getting the upper hand again in China. If we remember what Chinese entrepreneurs are able to do once they have become Overseas Chinese, we shouldn't be too surprised. But what works in China--and worked two centuries ago--does not have to work in Russia, not in Tolstoy's days and not today. I am not offering a solution; I only protest
against a naive universalism that knows only one recipe for development, the one supposed to have worked in the United States.

A Theory of Culture in Management Our trip around the world is over and we are back in the United States. What have we learned? There is something
in all countries called "management," but its meaning differs to a larger

or smaller extent from one country to the other, and it takes considerable historical and cultural insight into local conditions to understand its processes, philosophies, and problems. If already the word may mean so many different things, how can we expect one country's theories of management to apply abroad? One should be extremely careful in making this assumption, and test it before considering it proven. Management is not a phenomenon that can be isolated from other processes taking place in a society. During our trip around the world we saw that it interacts with what happens in the family, at school, in politics, and government. It is obviously also related to religion and to beliefs about science. Theories of management always had to be interdisciplinary, but if we cross national borders they should become more interdisciplinary than ever.

Cultural differences between nations can be, to some extent, described using first four, and now five, bipolar dimensions. The position of a country on these dimensions allows us to make some predictions on the way their society operates, including their management processes and the kind of theories applicable to their management.

As the word culture plays such an important role in my theory, let me give you my definition, which differs from some other very respectable definitions. Culture to me is the collective programming of the mind which distinguishes one group or category of people from another. In the part of my work I am referring to now, the category of people is the nation.

Culture is a construct, that means it is "not directly accessible to observation but inferable from verbal statements and other behaviors and useful in predicting still other observable and measurable verbal and nonverbal behavior." It should not be reified; it is an auxiliary concept that should be used as long it proves useful but bypassed where we can predict behaviors without it.

The same applies to the dimensions I introduced. They are constructs too that should not be reified. They do not "exist"; they are tools for analysis which may or may not clarify a situation. In my statistical analysis of empirical data the first four dimensions together explain forty-nine percent of the variance in the data. The other fifty-one percent remain specific to individual countries.

The first four dimensions were initially detected through a comparison of the values of similar people (employees and managers) in sixty-four

national subsidiaries of the IBM Corporation. People working for the same multinational, but in different countries, represent very well-matched samples from the populations of their countries, similar in all respects except nationality.

The first dimension is labelled Power Distance, and it can be defined as the degree of inequality among people which the population of a country considers as normal: from relatively equal (that is, small power distance) to extremely unequal (large power distance). All societies are unequal, but some are more unequal than others.

The second dimension is labelled Individualism, and it is the degree to which people in a country prefer to act as individuals rather than as members of groups. The opposite of individualism can be called Collectivism, so collectivism is low individualism. The way I use the word it has no political connotations. In collectivist societies a child learns to respect the group to which it belongs, usually the family, and to differentiate between in-group members and out-group members (that is, all other people). When children grow up they remain members of their group, and they expect the group to protect them when they are in trouble. In return, they have to remain loyal to their group throughout life. In individualist societies, a child learns very early to think of itself as "I" instead of as part of "we". It expects one day to have to stand on its own feet and not to get protection from its group any more; and therefore it also does not feel a need for strong loyalty.

The third dimension is called Masculinity and its opposite pole Femininity. It is the degree to which tough values like assertiveness, performance, success and competition, which in nearly all societies are associated with the role of men, prevail over tender values like the quality of life, maintaining warm personal relationships, service, care for the weak, and solidarity, which in nearly all societies are more associated with women's roles. Women's roles differ from men's roles in all countries; but in tough societies, the differences are larger than in tender ones.

The fourth dimension is labelled Uncertainty Avoidance, and it can be defined as the degree to which people in a country prefer structured over unstructured situations. Structured situations are those in which there are clear rules as to how one should behave. These rules can be written down, but they can also be unwritten and imposed by tradition. In countries which score high on uncertainty avoidance, people tend to show more nervous energy, while in countries which score low, people are more easy-going. A (national) society with strong uncertainty avoidance can be

called rigid; one with weak uncertainty avoidance, flexible. In countries
where uncertainty avoidance is strong a feeling prevails of "what is different, is dangerous." In weak uncertainty avoidance societies, the feeling would rather be "what is different, is curious."

The fifth dimension was added on the basis of a study of the values of students in twenty-three countries carried out by Michael Harris Bond, a Canadian working in Hong Kong. He and I had cooperated in another study of
students' values which had yielded the same four dimensions as the IBM data. However, we wondered to what extent our common findings in two studies could be the effect of a Western bias introduced by the common Western background of the researchers: remember Alice's croquet game. Michael Bond resolved this dilemma by deliberately introducing an Eastern
bias. He used a questionnaire prepared at his request by his Chinese colleagues, the Chinese Value Survey (CVS), which was translated from Chinese into different languages and answered by fifty male and fifty female students in each of twenty-three countries in all five continents.
Analysis of the CVS data produced three dimensions significantly correlated with the three IBM dimensions of power distance, individualism,
and masculinity. There was also a fourth dimension, but it did not resemble uncertainty avoidance. It was composed, both on the positive and
on the negative side, from items that had not been included in the IBM studies but were present in the Chinese Value Survey because they were rooted in the teachings of Confucius. I labelled this dimension: Long-term
versus Short-term Orientation. On the long-term side one finds values oriented towards the future, like thrift (saving) and persistence. On the
short-term side one finds values rather oriented towards the past and present, like respect for tradition and fulfilling social obligations.

Table 1 lists the scores on all five dimensions for the United States and
for the other countries we just discussed. The table shows that each country has its own configuration on the four dimensions. Some of the values in the table have been estimated based on imperfect replications or
personal impressions. The different dimension scores do not "explain" all
the differences in management I described earlier. To understand management in a country, one should have both knowledge of and empathy with the entire local scene. However, the scores should make us aware that
people in other countries may think, feel, and act very differently from us when confronted with basic problems of society.

Idiosyncracies of American Management Theories In comparison to other countries, the U.S. culture profile presents itself as below average on

power distance and uncertainty avoidance, highly individualistic, fairly masculine, and short-term oriented. The Germans show a stronger uncertainty avoidance and less extreme individualism; the Japanese are different on all dimensions, least on power distance; the French show larger power distance and uncertainty avoidance, but are less individualistic and somewhat feminine; the Dutch resemble the Americans on
the first three dimensions, but score extremely feminine and relatively long-term oriented; Hong Kong Chinese combine large power distance with weak uncertainty avoidance, collectivism, and are very long-term oriented;
and so on.

The American culture profile is reflected in American management theories.
I will just mention three elements not necessarily present in other countries: the stress on market processes, the stress on the individual, and the focus on managers rather than on workers.

The Stress on Market Processes

During the 1970s and 80s it has become fashionable in the United States to
look at organizations from a "transaction costs" viewpoint. Economist Oliver Williamson has opposed "hierarchies" to "markets." The reasoning is
that human social life consists of economic: transactions between individuals. We found the same in d'Iribarne's description of the U.S. principle of the contract between employer and employee, the labor market
in which the worker sells his or her labor for a price. These individuals
will form hierarchical organizations when the cost of the economic transactions (such as getting information, finding out whom to trust etc.)
is lower in a hierarchy than when all transactions would take place on a free market.

From a cultural perspective the important point is that the "market" is the point of departure or base model, and the organization is explained from market failure. A culture that produces such a theory is likely to prefer organizations that internally resemble markets to organizations that internally resemble more structured models, like those in Germany of
France. The ideal principle of control in organizations in the market philosophy is competition between individuals. This philosophy fits a society that combines a not-too-large power distance with a not-too-strong
uncertainty avoidance and individualism; besides the USA, it will fit all
other Anglo countries.

The Stress on the Individual

I find this constantly in the design of research projects and hypotheses; also in the fact that in the U.S. psychology is clearly a more respectable discipline in management circles than sociology. Culture however is a collective phenomenon. Although we may get our information about culture from individuals, we have to interpret it at the level of collectivities.
There are snags here known as the "ecological fallacy" and the "reverse ecological fallacy." None of the U.S. college textbooks on methodology I know deals sufficiently with the problem of multilevel analysis.

Culture can be compared to a forest, while individuals are tree. A forest is not just a bunch of trees: it is a symbiosis of different trees, bushes, plants, insects, animals and micro-organisms, and we miss the essence of the forest if we only describe its most typical trees. In the same way, a culture cannot be satisfactorily described in terms of the characteristics of a typical individual. There is a tendency in the U.S. management literature to overlook the forest for the trees and to ascribe cultural differences to interactions among individuals.

A striking example is found in the otherwise excellent book Organizational Culture and Leadership by Edgar H. Schein (1985). On the basis of his consulting experience he compares two large companies, nicknamed "Action" and "Multi." He explains the differences in culture between these companies by the group dynamics in their respective boardrooms. Nowhere in the book are any conclusions drawn from the fact that the first company is an American-based computer firm, and the second a Swiss-based pharmaceutics firm. This information is not even mentioned. A stress on interactions among individuals obviously fits a culture identified as the most individualistic in the world, but it will not be so well understood by the four-fifths of the world population for whom the group prevails over the individual.

One of the conclusions of my own multilevel research has been that culture at the national level and culture at the organizational level--corporate culture--are two very different phenomena and that the use of a common term for both is confusing. If we do use the common term, we should also pay attention to the occupational and the gender level of culture.
National cultures differ primarily in the fundamental, invisible values held by a majority of their members, acquired in early childhood, whereas organizational cultures are a much more superficial phenomenon residing mainly in the visible practices of the organization, acquired by socialization of the new members who join as young adults. National cultures change only very slowly if at all; organizational cultures may

be consciously changed, although this isn't necessarily easy. This difference between the two types of culture is the secret of the existence of multinational corporations that employ, as I showed in the IBM case, employees with extremely different national cultural values. What keeps them together is a corporate culture based on common practices.

The Stress on Managers Rather than Workers

The core element of a work organization around the world is the people who do the work. All the rest is superstructure, and I hope to have demonstrated to you that it may take many different shapes. In the U.S. literature on work organization, however, the core element, if not explicitly then implicitly, is considered the manager. This may well be the result of the combination of extreme individualism with fairly strong masculinity, which has turned the manager into a culture hero of almost mythical proportions. For example, he--not really she--is supposed to make decisions all the time. Those of you who are or have been managers must know that this is a fable. Very few management decisions are just "made" as the myth suggests it. Managers are much more involved in maintaining networks; if anything, it is the rank-and-file worker who can really make decisions on his or her own, albeit on a relatively simple level.

An amusing effect of the U.S. focus on managers is that in at least ten American books and articles on management I have been misquoted as having studied IBM managers in my research, whereas the book clearly describes that the answers were from IBM employees. My observation may be biased, but I get the impression that compared to twenty or thirty years ago less research in this country is done among employees and more on managers. But managers derive their raison d'Etre from the people managed: culturally, they are the followers of the people they lead, and their effectiveness depends on the latter. In other parts of the world, this exclusive focus on the manager is less strong, with Japan as the supreme example.

Conclusion This article started with Alice in Wonderland. In fact, the management theorist who ventures outside his or her own country into other parts of the world is like Alice in Wonderland. He or she will meet strange beings, customs, ways of organizing or disorganizing and theories that are clearly stupid, oldfashioned or even immoral--yet they may work, or at least they may not fail more frequently than corresponding theories do at home. Then, after the first culture shock, the traveller to Wonderland will feel enlightened, and may be able to take his or her

experiences home and use them advantageously. All great ideas in science,
politics and management have travelled from one country to another, and been enriched by foreign influences. The roots of American management theories are mainly in Europe: with Adam Smith, John Stuart Mill, Lev Tolstoy, Max Weber, Henri Fayol, Sigmund Freud, Kurt Lewin and many others. These theories were re-planted here and they developed and bore fruit. The same may happen again. The last thing we need is a Monroe doctrine for management ideas.

The issues explored here were presented by Dr. Hofstede, the Foundation for Administrative Research Distinguished International Scholar, at the 1992 Annual Meeting of the Academy of Management, Las Vegas, Nevada, August 11, 1992.

Table 1 Culture Dimension Scores for Ten Countries
PD = Power Distance; ID = Individualism ; MA = Masculinity;
UA = Uncertainty
Avoidance; LT = Long Term Orientation)
H = top third, M = medium third, L = bottom third (among 53 countries and regions for the first
four dimension; among 23 countries for the fifth)

Legend for Chart:

B - PD
C - ID
D - MA
E - UA
F - LT

	B	C	D	E	F
USA	40 L	91 H	62 H	46 L	29 L
Germany	35 L	67 H	66 H	65 M	31 M
Japan	54 M	46 M	95 H	92 H	80 H
France	68 H	71 H	43 M	86 H	30[*]L
Netherlands	38 L	80 H	14 L	53 M	44 M
Hong Kong	68 H	25 L	57 H	29 L	96 H
Indonesia	78 H	14 L	46 M	48 L	25[*]L
West Africa	77 H	20 L	46 M	54 M	16 L
Russia	95[*]H	50[*]M	40[*]L	90[*]H	10[*]L
China	80[*]H	20[*]L	50[*]L	60[*]H	118 H

[*] estimated

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Section 3: Technological Innovation in e-Health

Structures Surrounding e-Health: Effects of Legal and Administrative Structures on Development of IT in Health Care Services – focus on Finland.

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Introduction

During the latter half of the 20th and the beginning of the 21st centuries developments in information technology (IT) and automating work have changed the work processes in most information-heavy fields of human activity, resulting in gains in productivity and reducing the effects of human error[1]. This has generally not been the case for the health care sector, except for automating some financial and administrative tasks. The technologies necessary for reorganizing work even in this sector have existed for some time, but wide adoption of these technologies has been slower than one would expect. As the world economic growth has slowed down after the 90's, health care systems in most of the industrialized world are facing increased pressure towards enhanced efficiency due to diminishing public financing and an aging population[2]. The need for increased use of new technology and new work methods is clearer than ever.

Introduction of new technology does, of course, not solve the problems of the field as such; proper implementation and wide enough use of the systems are important requirements.

The use of semi-automated processes and partially implemented systems can even have adverse effects on efficiency and quality of care, as suggested by Lederman and Morrison[3].

There is an observable difference in IT usage between public and private health care institutions, at least in Finland. The private clinics have a direct financial incentive to cut costs and to maximize the satisfaction of their customers, whereas the public institutions are constantly struggling with financing problems and understaffing and generally lack the ability to invest in the newest technology. The health service providers are, however, not the only players in the field of healthcare. Insurers, pharmacies, laboratories and regulating bodies all have their stake in the

structure of health care systems, and cooperated efforts are necessary for truly beneficial changes. It seems that the private health care enterprises are embracing disruptive technologies to enhance their efficiency just as discussed in the classic article, but the public organizations are more prone to use new technology to support existing processes thus limiting the scope of organizational change.

The critical changes of the processes and implementation of better systems will not even be possible until the information systems in different organizations are able to function together and the critical information flows between the organizations are automated. Technological innovations as such will only function as catalysts of required organizational change, but as such catalysts these are invaluable. This is clearly visible in the layered presentation of the problem field presented in this book; Technological innovation can only thrive where the underlying cultural and organizational contexts allows and encourages it, and even then the level of success depends on management of change, cooperation between the stakeholders and, fundamentally, on changes in the mental models about healthcare processes.

This article is composed as follows: firstly, we describe the organizational framework in Finland within which the e-health services exist, and look at administrative issues within the framework that are not supportive of advancement in the sector. Secondly, we elaborate some issues particular to e-health from a legal perspective. Thirdly, we address the discussed issues from the point of view of some of the actors in the sector. We base the third part on a small (non-representative) survey sent to actors in the field of health services in South Western Finland. Finally, we draw some conclusions and summarize.

Organizational environment in Finland

In Finland health care is basically organized around publicly financed organizations and supported by private institutions in larger cities. The universal health insurance provided by the Social

Insurance Institute of Finland (SIIF) covers use of the public health care services fully and a percentage of the privately produced services [4], for example 60% of the private doctor's fees [5] A certain level of health care is guaranteed by law for every Finnish citizen. The primary administrative units, the municipalities, have since the 1990's had the right to choose how the services demanded by law are produced, including buying the services from private service providers [6].

The private service providers act as a catalyst for restructuring even the public systems by showing in practice that the same services can be produced with a smaller use of resources.

Despite the existence of a universal health insurance the citizens tend to be insured even in private insurance companies, either by themselves through home insurance healthcare packages (covering mainly accidents etc.) or by their employers. This complicates the administrative processes in cases of work-related illnesses, acute injuries and other situations where a patient is insured by several organizations.

Due to the independence of the municipalities the health systems in different parts of the country are very different from each other, all naturally providing the level of service required by law. In most districts there are organizations for everyday illnesses, for special care, in-patient wards etc. that have all been founded at different times and there is no generally applied organizational structure even within the municipalities or health districts. The existence of different organizational cultures within the bigger health care structures cause some administrative problems of their own, but even make development of information systems difficult due to differences in work processes and information requirements.

Information systems compatibility is a major issue in developing functional health care systems [7]. In Finland the fragmentation of information systems has been a major obstacle on the road towards systems that would significally alter the processes of the health care system, increasing efficiency

and effectiveness. This situation has been noted by the governing authorities, and the Ministry of Social Affairs and Health has started a project for preparing a nation-wide electronic health record system. The project is organized as a work group and the main objective is to define the contents and criteria for a national electronic health record system and to maintain a cooperation network for implementing the system. The workgroup presented a strategy to the Minister of Social Affairs and Health in January 2004. This strategy contains standards for data structures, data communication protocols and data security that are to be implemented by all health centers and hospitals by 2007[8]. This provides the public sector with not only a more secure environment for investing in information technology but even with a direct incentive to do so.

Some examples of IT use in the Finnish Health Care System

Electronic prescriptions

Delivering drug prescriptions electronically has been possible in principle since the 1995 Ministry of Social Affairs and Health regulation for delivering prescription drugs. The regulation allowed for electronic data transfers on a general level but provided no specific guidelines as to how the system should work.

There have been two major publicly financed pilot projects around electronic prescriptions in Finland: the SIIF smart card project in 1989-1993 and the health care cooperation project in the Satakunta region 1998-2000 called Satakunnan Makropilotti. The smart card project used personal health cards as data storage for prescriptions. It was a limited success, but the system was never intended to be the default system for the whole country[9]. The Makropilotti project had as its main goal to develop information technology (local information system, reference database, secure email and local service portal) to support service development in health and social services. A special law was enacted to enable patient data transfer between the different organizations within the seven

municipalities partaking in the pilot. The electronic prescription service never got to wider pilot use and the project was terminated in 2000. The project cannot be described as a success as such but it unveiled a number of obstacles in the way of developing health systems: there is (i)no clear structure for service development, (ii)unclear limits of responsibilities and (iii)no authority governing the whole customer service process [10].

Based on the previous experiences the Ministry of Social Affairs and Health has in November 2003 initiated a more extensive pilot for testing electronic prescriptions. The pilot covers four public health care districts and a number of private pharmacies, and is based on a central prescriptions database maintained by the SIIF. The serious involvement of the SIIF will relieve the users of the pilot system from most of the insurance-related paperwork, thus enabling true process improvements. The pilot project is legally based on a special decree of the Ministry of Social Affairs and Health (771/2003) and will run until the end of 2004. Should the results of the pilot be positive, the permanent legislation around the subject is likely to be changed rapidly.

One of the central obstacles in developing electronic prescriptions has been the absence of clear norms and standards about, among other things, electronic signatures which verify the identity of the describing doctor [9]. The law governing electronic signatures was passed in the Finnish parliament 24. Jan 2003, and defines the acceptable forms of verification for electronic interaction with public servants and government organizations[11]. This alone will not remove all of the problems, but now there is at least basic jurisdiction on which future guidelines can be built.

Telemedicine

There are a number of telemedicine applications in use in Finland, especially in northern parts. The Finnish Office for Health Care Technology Assessment (FinOHTA) together with Northern Ostrobothnia Hospital District, organized a project to assess the effectiveness and the cost-effectiveness of telemedicine, focusing on applications in radiology, psychiatry, surgery and

ophthalmology. The personnel using the systems learnt the new methods fast, but usability of the systems was not deemed perfect. The main advantages lie in reduced travelling of the personnel, making telemedicine applications financially viable only over considerable distances as in Northern Finland. [12] Telemedicine applications have to struggle with the same legal and organizational problems as the rest of health care informatics: the electronic connection is understood as an extension of the presence of the doctor/patient and transfers of medical data between organizations is still subject to several data secrecy laws and regulations.

Electronic patient records and image processing

There are several different electronic patient record systems in use, as well as different image processing systems. One of the main tasks of the work group mentioned above is to create guidelines for nation-wide compatibility. Most of the electronic imaging systems in use in Finland are compliant with the DICOM (Digital Imaging and Communications in Medicine) standard, and the EHR (electronic health records) systems built today are following HL7(health level 7) structures. There are functioning region-wide radiology information systems (RISs) in the Turku and Helsinki regions, enabling remote consultations and digital archiving of the images, and similar systems are under development in other regions[13]. These systems will probably not be fully compatible as the regulation governing them is very vague, and the systems are, naturally, developed by competing systems development companies each trying to add features their competitors did not include. The basic structures do, however, follow the international standards so a general mishmash like the one created in the hospitals of Finland in the seventies by a large number of in-house development projects could be avoided.

Legal issues affecting e-Health implementation

E-Health services consist of parts that are not unknown to legislation. However, as a combination of electronic and physical transactions e-Health is unique, and there are very few laws that are specifically drafted to answer to the special circumstances of e-Health, or cyber medicine. The major parts that make e-Health are telecommunications, information technology and health services. Each one of these is governed by a set of laws, which are special to each one of the parts. E-Health is therefore governed by a combination of the laws governing its parts. This means that there are a number of regulatory and other legal issues that govern e-Health directly or indirectly.

Below we present some issues that are special for e-Health, and are known to hinder the implementation of e-Health services:

1. Medical data and patient data enjoy a high level of protection of privacy in many legal systems. For controlled substances identification of the buyer is important.

When patient information is transmitted between doctors within a company, usually there doesn't seem to be any problems with regulation and jurisdiction, as in-house systems are perceived as closed systems. However, when patient data is transferred from one service provider to another (e.g. public to private or vice versa) there may be problems of compatibility between systems and different security measures in place. The systems of the public organizations are required to keep archives of every document connected to their actions [14]. Archives do not need to be on paper anymore, but in some organizations most of them are. This causes some administrative problems in trying to create seamless information flows. It is not unacceptable to think that from the point of view of security, the systems used in private sector are at least of the same quality, if not of higher quality, than in the public sector. However, as the legal requirements are different or carried out differently, systems compatibility between private and public sector systems is not easily achieved.

It seems that protection of anonymity of patients and the secrecy of information is not an issue that creates obstacles, however, the discussion is about what kind of cryptography and other security measures need to be in place for growing flows of patient information.

The marketing and selling of controlled substances (e.g. certain medicines) brings forth another issue: validating the identity of the buyer is necessary to ensure that the substances are not ending up in the wrong hands. If, for example, medication is sold through the Internet, it is plausible to think that the service must at some point include an identity check - how this is accomplished is not clear. Another issue, although connected to selling of controlled substances, is the issue of electronic drug prescriptions. If a doctor electronically transfers information to pharmacies (or to a data base, where pharmacies can check prescriptions for patients), problems with counterfeit prescriptions can be circumvented, providing that the practitioners using the service operate according to the law, and can be identified. Now as the new law governing electronic signatures is in place in Finland the communication between doctors and pharmacies could be arranged. As the SIIF is involved in most of the medication transactions and there was no paperless system (or even precise guidelines for developing one) for delivering insurance claims to the SIIF, prior to launching the pilot project mentioned above, the systems development was slow. Development of fully paperless systems is still hindered by the National Agency for Medicines (NAM) requirements. NAM requires paper records of all the delivered drugs as well as 10 year archiving of prescriptions (original paper documents) of certain drugs affecting the central nervous system, as well as drugs classified as narcotics [15].

2. There is no universal licensing system for medical practitioners which would govern international medical consultations made through the Internet.

Because there is no international community for medical practitioners that would or could give licenses to practitioners that ensure quality of the service, it is difficult for a user of e-Health services offering medical consultations to be sure of the quality of the product. If there is a risk that someone is posing as a medical practitioner (doctor) it jeopardizes the credibility of e-Health.

Another issue that may play an important role in the acceptance of e-Health services is the position that different patient insurance systems take towards them. If insurance will cover consultations made through the Internet, or perhaps a mobile device, there is considerably less hindrance for adaptation by users. In the case of private insurance the step to accept at least some selected e-Health services may be low. However, in cases of public insurance (e.g. Finland), the process of acceptance may be a long registration and regulatory process.

3. Issues of contracts between parties in transactions made through the Internet may in some cases resemble transactions *not made* through the Internet. However, in cases of litigation, Internet presents problems.

Important questions arise, like where a transaction, or in the case of e-Health, a consultation has taken place when a patient resides in another location than the service provider. In other words, which country's jurisdiction is applied in, for example malpractice suits filed on consultations made over the Internet? This type of problems are avoided if services operate within national borders. However, as the Internet is global it is not hard to imagine problems arising from enforcing and litigating contracts signed only on the Internet.

The number of issues that do not have a clear answer is large, this means that there is considerable uncertainty as to what can (and what cannot) be done by providers of e-Health services. This

translates to management decisions about investments in the sector, and means that investments can be postponed, because the companies do not wish to find themselves in situations where their investments are suspended by regulatory decisions. Paradoxically it seems that it is not possible to get binding pre-investment information about the regulatory status of projects, or getting such information will take so long that the investment is no longer worthwhile and getting the information is a very exhausting process. The initial answers from the Finnish regulatory bodies concerning a number of possible projects have been ex-ante negative, which means there has been very few stakeholders who even begun to explore innovations other than those they knew to be possible.

Views of stakeholders about the administrative and judicial framework governing IT in health services.

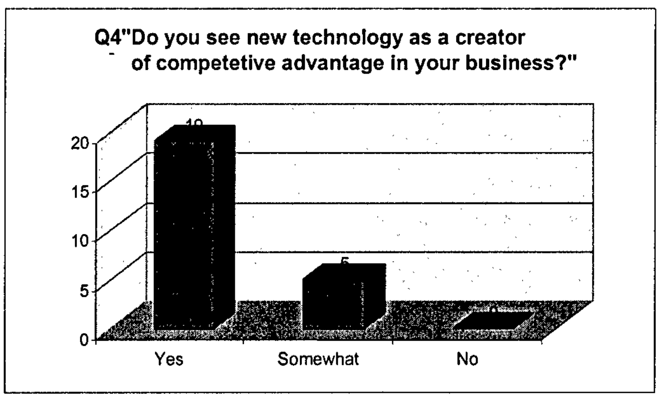
In order to understand better the feelings and thoughts of the actual stakeholders in the field of health services production, an exploratory survey about the use of e-Health was prepared in cooperation with students from the Turku School of Economics and Business Administration in 2002. The survey was sent to approximately one hundred companies providing healthcare services, ranging from pharmacies and individual private doctors to large health care centers. Answers were received from 25 companies, usually from managers responsible for investments in IT in the company. The questions on the survey varied from basic questions about the readiness of the respondents to utilize different e-Health innovations (in connection with the Internet) and what their attitudes are towards e-Health as an addition to their business generally and specifically. One of the issues taken up in the questionnaire was the interest of parties to engage in using e-prescriptions. The reason for this was that the authors were aware of the difficulties in the development of systems regarding e-prescriptions and the administrative hindrances that are slowing the progress of using e-

prescriptions. The authors wish to point out that the survey is not a representative survey and the results are only exploratory. Therefore they can only be used in creating a basic understanding of the attitudes of the community of health service providers in Finland.

In the following we will go through the results from the survey in four phases, according to issues that were thought relevant by the authors:

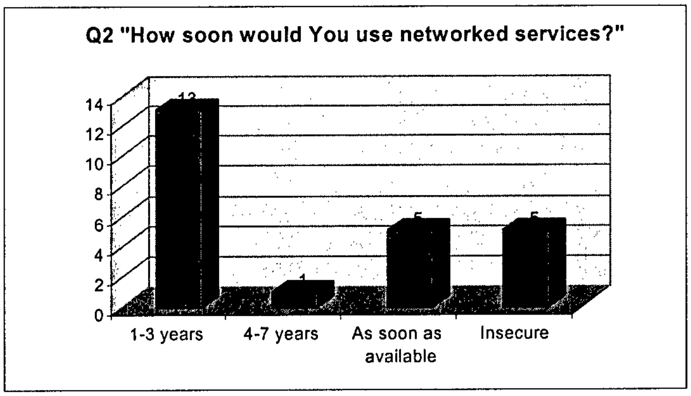
i) It seems that the stakeholders are positive about the use of IT and feel that it has potential for enhancing their productivity.

Fig.1: Opinions on new technology as a source of competitive edge



Three fourths of the respondents (75%) indicated that they were either ready immediately or would be ready within 1-3 years to use e-Health services. Only one respondent answered that it would take them more than 3 years. The rest were not sure how long it would take. More than 86% of the responses indicated that the respondents already have the needed infrastructure and readiness for launching e-Health services. More than 87% of the respondents reported that they feel that new technology gives at least to some extent a possibility to gain competitive advantages in the field. The term "e-Health" is not very commonly known to the companies in the field; however, on the basis of their readiness and attitudes most companies are ready to adopt e-Health services very fast.

Fig.2: Readiness to use e-Health(networked) services



ii) In-house tasks are often already done with IT-solutions, and there are positive experiences.

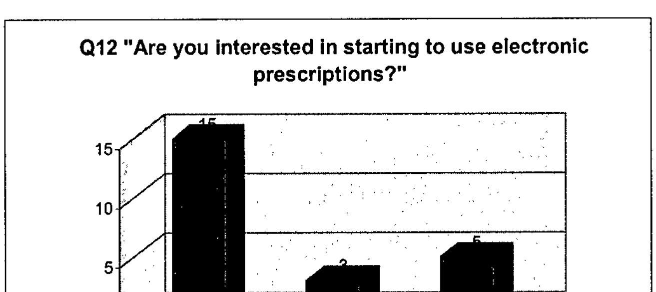
All the answers indicated that the respondents feel that an information system is or would be important to their operations, and more than 86% stated that they have a functioning information system at work in their business. Roughly 54% of the respondents said that they either were thinking about using the Internet as a marketing channel for their products, or are already using it (~21%). The number of answers that were negative to using the Internet as a marketing channel has partly to do with the fact that 7 of the responding firms were pharmacies. Pharmacies are highly regulated in Finland and it seems that even if regulation is not prohibitive in all aspects of marketing via the Internet, it seems to be a hindering factor. It is probable that marketing alone is not perceived as a sufficient justification to build new systems. For those respondents who have already been using the Internet as a channel for their marketing, their experiences have been mostly positive. 25% of the respondents indicated that they have plans to sell their products on the Internet, but only one indicated that they have actually sold their products via the Internet. They had positive experiences due to enhancements in routines of ordering and delivery with customers who were using the Internet service. From the answers of the pharmacies that had not sold their products in the Internet, the comments specified that this was due to administrative and regulatory hindrances; selling drugs on the Internet is not presently allowed. Further comments stated that the actual

delivery of the drugs would have to be realized by a credible and trustworthy company. One response suggested that the products that would most likely be sold over the Internet would be products already most well known to the customers (at least in the case of retail customers). On a further note, some of the respondents are actually service providers and do not per se concentrate in selling any products. The attitudes towards Internet as a way to enhance their business varied from mildly reserved to very positive. Also a concern over the truthfulness of information mediated through the Internet was voiced in one answer.

iii) On a number of occasions it was mentioned that the administration by the Social Insurance Institution of Finland (SIIF) and the National Agency for Medicines (NAM) are hindering development.

From the limited material at our disposal we could detect a feeling of frustration from among the respondents. It seems that there is a wall that the service providers and especially pharmacies are facing when trying to launch innovations in the level of preliminary acceptance from the administrative bodies. It seems to us that as companies' internal information systems do not fall under the jurisdiction of the governing bodies they seem to be experiencing constant development, and are used to enhance the operational efficiency of the companies. The thought just expressed is not based on any extensive research material, but is rather derived from the loosely structured information and based on the survey results.

iv) Most of the respondents specify that incorporationg electronic drug prescriptions would be an



important step. This is, however, not possible due to administrative hindrances.

Fig 3: Interest in electronic prescriptions

Nearly 80% of the answers stated that the businesses would be interested in using electronic drug prescriptions. One answer stated that based on observations from a longer period of time it seems quite hard to expect any changes in the near future due to lack of cooperation from administrative bodies.

In general it can be said that most of the respondents have an information system in use and that they have a positive picture of IT in the production of health services. This indicates that there is interest within companies to develop their information systems to further enhance their productivity and services. However, it was quite obvious that stakeholders feel uncertain about pursuing development in IT as the administrative and legal frameworks are not transparent.

Discussion and conclusion

We have introduced the main setting of the Finnish administrative framework for health care services and seen that service production is divided into the services provided by private companies and the public services. There is a gap between the productivity of private services and public services and we feel that one of the reasons for the existence of the gap can be more advanced use of IT. One factor hindering the development in the public sector – and indirectly even the private sector, as the systems will need to communicate with each other- is the existence of administrative and legal barriers that do not take into account the possibilities offered by the technologies available today. Legislation and administration have not been able to develop in pace with technical innovations. This has caused a bottleneck in areas such as production of health care services that

have a strong focus on privacy and customer (patient) protection. The lack of up-to-date governance (laws and administration) of IT in health care is a major source of uncertainty and a serious hindrance for development in the sector. The obvious conclusion is that in order to work optimally from the point of view of all stakeholders, the legislation and administration of IT in health care service production should be brought up-to-date with the technological advances, otherwise we will most likely see a stagnation in the development of such systems. Companies operating in the field of health services provision need proof of cooperation from the regulators to invest in and fully embrace new technology. The legislation, of course, has as a main goal to secure the quality and accountability of care, and laws in the health field cannot be changed radically overnight as the organizational structures are built around the existing ways of practicing medicine. But without proper standards, guidelines and legislation, even incremental changes may be deemed impossible. The processes within tradition-bound and complex health care organizations are difficult enough to change due to organizational inertia and resistance to change, so every hindering factor from the surrounding society may turn into a major obstacle. The very slowly diminishing uncertainty about the legal and administrative issues in implementing and designing IT infrastructure in Finland has been felt by companies operating in the sector. Our survey found that companies would be interested in implementing new systems but are sometimes unable to do so, because of institutional constraints. A fast pre-approval procedure for health care systems by regulators or a set of clear rules and principles of conduct would promote acceptance and implementation of IT in the health care sector. The latest developments in legislation and the numerous government projects aiming at developing guidelines for IT in health care do manifest a commitment to change in the highest levels of administration, but the health care sector will probably nevertheless remain a few years behind the rest of our society in the field of information technology usage.

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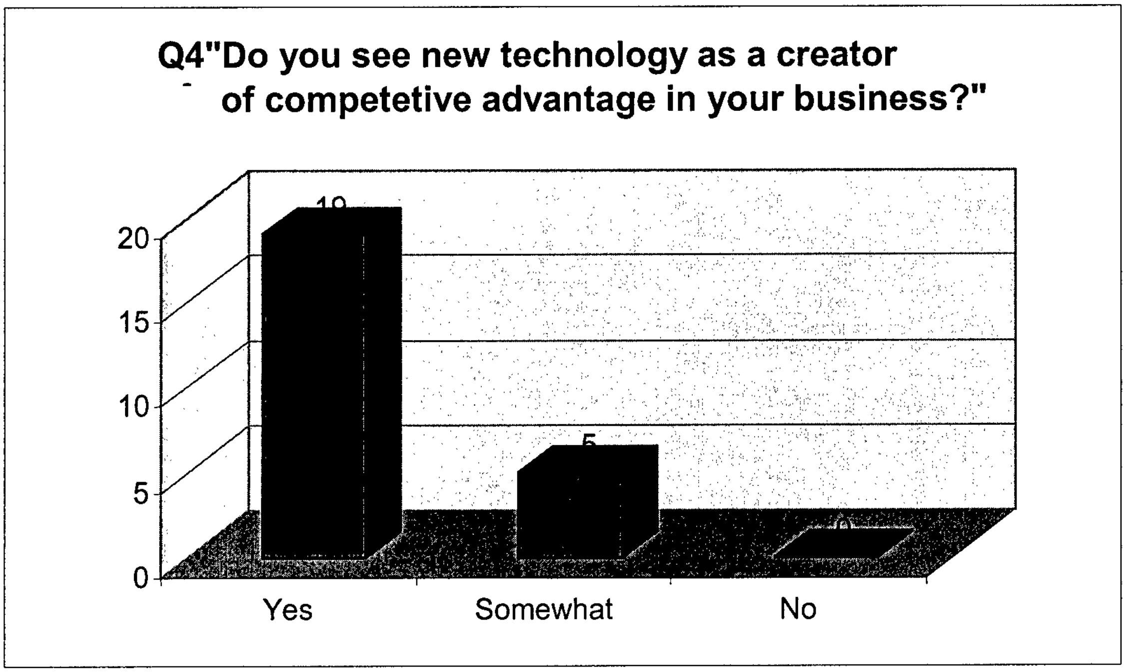
Q4"Do you see new technology as a creator
of competetive advantage in your business?"
20
15
10
5
0
Yes
Somewhat
No

Figure 1

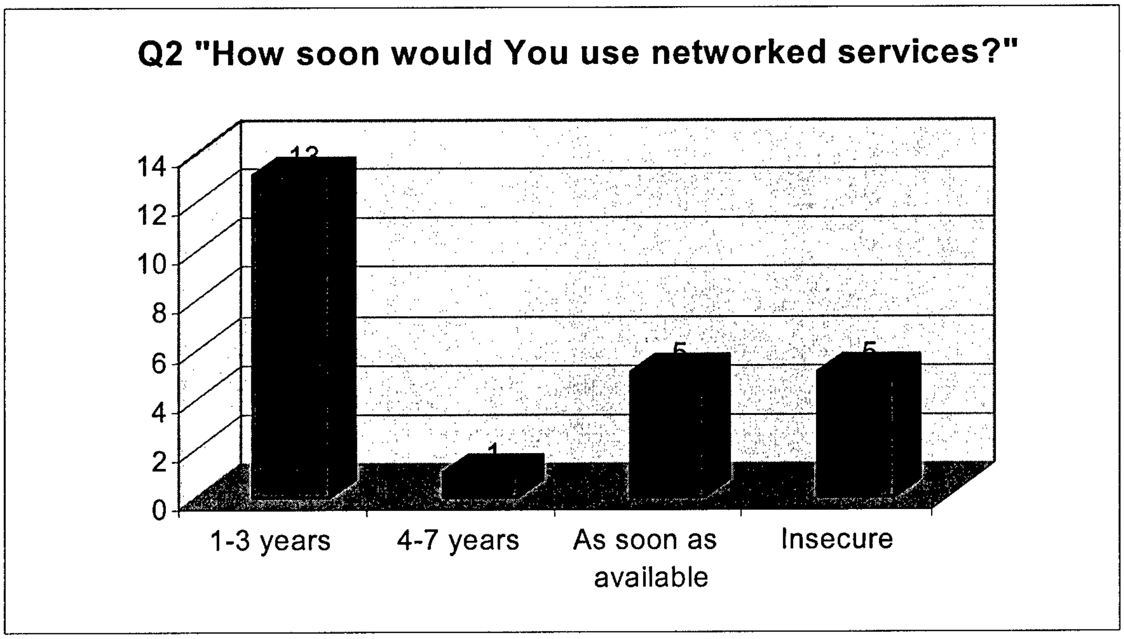
Q2 "How soon would You use networked services?"
14
12
10
8
6
4
2
0
1-3 years
4-7 years
As soon as available
Insecure
1
5
5

Figure 2

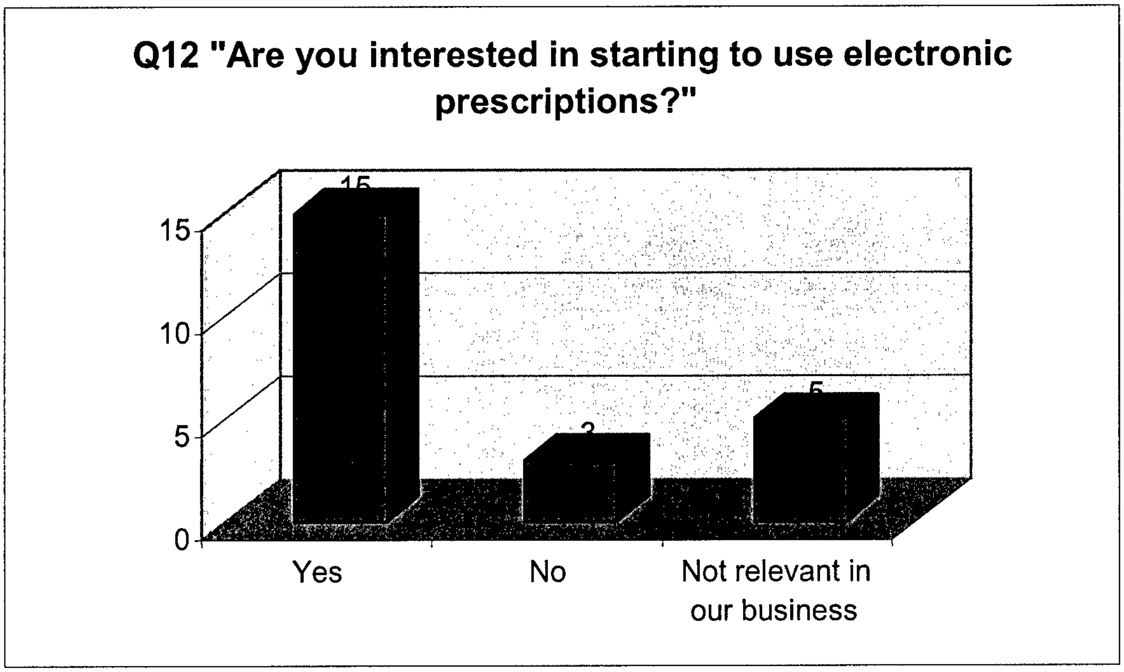
Q12 "Are you interested in starting to use electronic prescriptions?"
15
10
5
0
Yes
No
Not relevant in our business

Figure 3

Secure, Remote, Ubiquitous Access of Electronic Health Records

John Fulcher

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1. Background

The provision of healthcare necessarily involves the generation, collation, storage and access of patient data, in an ethical and legal manner. Furthermore, both patients and managers need to be assured that whatever system is in place is inherently confidential, secure and accountable. The latter implies some form of audit trail to assist in dispute resolution. Traditional paper-based records rely on physical security measures, such as safes, locks and controlled office and/or building access. Moreover, access to patient data belonging to other healthcare providers at remote sites necessarily involves copying, transmitting and securely storing third-party patient records.

The following summarizes the security needs (so-called trust issues) which must be satisfied within any system, be it healthcare or otherwise [1]:

1. authority –in any particular domain, a trusted authority must exist who issues not only their own identity, but also the identities of individuals further down the chain of command.
2. identity – procedures need to be put in place to ensure identities are

only issued to individuals who *should* have access to the system; traditionally, paper-based identities are often protected by way of photographs, holograms and/or lamination.

3. authentication – involves the positive identification of an individual, for example by way of paper-based IDs (such as birth certificates, driving licenses, passports), signed written letters of authority, or fingerprints.
4. authorization – is the process of granting permission to authenticated users. In the medical field this could take the form of licensing doctors to practice in various states and territories. Alternatively a hospital administrator may be authorized to create new patient records, but not to alter the medical information contained therein.
5. confidentiality – only authenticated, authorized people are allowed access to their data stored in the system in question.
6. integrity – information cannot be modified by unauthorized users.
7. non-repudiation – is the ability to guarantee that a specific transaction occurred on a particular date and/or time. Traditionally this often takes the form of a public notary witnessing signatures on a document.

In this Chapter we concern ourselves with the transition currently underway within the healthcare industry towards Electronic Health Records – EHRs – and the repercussions this has for the secure, remote access of patient data.

2. The move towards EHRs

Access, ownership and privacy of medical records are fundamental considerations in any eHealth application [2-6]. Indeed, social, political and/or legal concerns – rather than technological ones – often dictate the final deployment of eHealth systems in the field.

It would appear that most stakeholders agree that eHealth (Health Informatics) is inevitable, despite there being a lack of consensus on its implementation details. For example, the European Union views eHealth as showing promise for improving quality, cost and access. At the same time, they cite the following barriers and pitfalls: the need for organizational change, cross-organisational cooperation and adherence to standards [7]. The eEurope 2005 Plan identifies several promising fields, including health cards which contain basic patient data, connectivity of healthcare providers and points-of-care, as well as on-line information, all of which would be supported by "broadband networks and a culture of security, which lie at the heart of many future electronic services."

In the US, security is viewed as paramount to the success of eHealth systems, although the Health Insurance Portability and Accountability Act – HIPAA – does not go beyond a motherhood statement touting a "common sense" approach for implementing security for internal systems and processes [1]. An alternative model of healthcare, in which the public is becoming increasingly more participatory, has been proposed in Canada [8]. The Canadian Institute for

Health Informatics has observed individuals increasingly requesting access to their own health data, and storing it electronically using "my health record" software, which is becoming increasingly more available on eHealth websites.

Within this context, numerous authors cite the potential advantages of moving from paper-based to Electronic Health Records, one of which is the reduction of errors contained therein. A recent US study, for example, found that the annual toll from preventable errors exceeds the combined number of deaths and injuries from road and air crashes, suicides, falls, poisonings and drownings [9]. Given this, the widespread adoption of EHRs is therefore seen as having potential for significantly increasing consumer safety. The irony with electronic storage of patient health (medical) records however is that whilst most stakeholders agree on the general principle, there is no consensus on *specific* formats.

EHRs contain their own inherent risks; first and foremost, digital records may be read, modified and/or copied by (unauthorized) hackers. A common misconception is that the chief risk to privacy and confidentiality is from intruders breaking into the system from outside. In reality, accidental or malicious disclosure (by disgruntled employees, for instance), insider curiosity or uncontrolled secondary usage (such as on-selling to unauthorized third parties) can often render systems much more vulnerable [10-12]. To take but one recent example: a Florida state Health Department worker recently compiled a list of 4,000 people infected with HIV and forwarded this information to the St.

Petersburg Times and Tampa Tribune [1].

We now revisit the security trust issues cited in Section 1. <u>Identity</u> in the digital age often takes the form of Personal Identification Number – PIN – or username/(encrypted)password. These are quite vulnerable to intruders, and as such cannot be considered sufficiently secure. Numerous anecdotes abound in the IT industry which indicate that users' behaviour patterns can negate what little security is inherent in the system. Consider for example, the following: using "password" as the password, or 100% of doctors in one particular practice using "doctor" as their password, or perhaps worst of all – affixing post-sticks on which the passwords are written to the computer monitor! In a digital environment, <u>integrity</u> can be assured through the use of digital signature (hashing) algorithms, which when combined with (secure) time stamping, can reveal subsequent attempts to alter the data. Lastly, digital transactions ensure <u>non-repudiation</u>, since they utilize digital signatures by strongly authenticated and authorized users [1].

As already stated, security, confidentiality and privacy is ensured in computer systems by way of encryption, common industry standards being Public Key Infrastructure – PKI – and Pretty Good Privacy – PGP. One-time (volatile) passwords guard against *re-use* of valid passwords which may have fallen into the hands of unauthorized system users. Hardware tokens, such as smart cards or USB iKeys, can also be useful in this regard. Systems can be rendered even

more secure by incorporating biometrics – those physical characteristics which "uniquely" distinguish humans from each other (Section 6). However the bottom line is that because all the above techniques store information in digital form, there remains the possibility, however slight, of an intruder hacking into a system and stealing this information (even to the point of committing identity theft, as occurs with paper-based systems).

Duty-of-care principles dictate access to medical records within the Australian context. The Federal Department of Health and Aged Care acknowledges that the increased computerization of doctors' general practice is occurring in an *uncontrolled* environment. Likewise, the Australian EHR Task Force acknowledges that more work needs to take place with both messaging standards and security (PKI). They further suggest that (a) HL7 be adopted as the messaging standard, and (b) XML be adopted as the preferred technology medium for health information interchange (http://www.noie.gov.au/projects/ecommerce/ehealth/index.htm).

The linking of various EHRs cannot proceed without the confidence of the public, especially as regards compliance with privacy and other similar legislation [6]. With this in mind, The Federal Government recently conducted trials in two Australian States, with the longer-term aim of developing a national eHealth information network (http://www.healthconnect.gov.au). One of these trials was conducted with remote indigenous (Aboriginal) health services in the Katherine

region of the Northern Territory, and the other with an aging population residing in Hobart, Tasmania.

3. Access, Ownership, Confidentiality and Ubiquity

In April 2003, the US Department of Health & Human Services – HHS – introduced comprehensive federal legislation that gives patients sweeping protections over the privacy of their medical records. In the words of HHS Secretary Thompson: "Patients now will have a strong foundation of federal protections for the personal medical information that they share with their doctors, hospitals and others who provide their care and help pay for it." (http://www.hhs.gov/ocr/hippa). Under this privacy legislation:

(i) patients must first give specific authorization before entities covered by the regulation can use or disclose protected information,

(ii) covered entities need to provide patients with written notice of their privacy practices and patients' privacy rights,

(iii) pharmacies, health plans and other covered entities must first obtain an individual's specific authorization before sending them marketing materials, and

(iv) patients will be able to access their personal medical records and request changes to correct any errors.

The legal position in Australia is that medical records are *jointly* owned by both

doctor and patient. The key aspects of the recently enacted Guideline on the Private Health Sector (http://www.privacy.gov.au) are access, collection, disclosure and use, with particular emphasis on "voluntary, informed consent". The Australian Privacy Commissioner is of the view that we must "ensure all consumers can confidently take maximum advantage of the information economy while allowing them to protect their privacy with minimum inconvenience" [14].

There are widely differing views as to whether the addition of biometrics would be privacy enhancing or privacy restricting [14,15]. Such privacy concerns override questions of access and ownership, which in turn override the technical issues surrounding remote access and security. What are the consequences of unauthorized eavesdropping on confidential medical records? For example, "outing" of people's specific medical problems could have dire consequences, even in the case of de-identified data. We shall return to consider biometrics in Section 6.

On the issue of ubiquity [16,17], it has been observed in Canada that the geographic location of health services is becoming less of an issue. Perhaps the "anywhere, anytime, anyplace access to patient medical records" – unrealized a decade ago in the then "age of increasing mobility within the global economy" [18] – is beginning to emerge? The access model reported in Section 5.3 goes part of the way to enabling ubiquity in relation to the secure, remote access of EHRs.

4. Unique Patient Identifiers - UPIs

As is the case with EHRs, most stakeholders regard Unique Patient Identifiers – UPIs – as holding potential benefits in an eHealth setting, for instance the enhancement of privacy, confidentiality and security [8]. Unfortunately, just as with EHRs, there is a lack of agreement on exactly how "uniqueness" is quantified in this regard. The practice of assigning random digits, as with 16-digit credit card numbers, or 4-digit Automatic Teller Machine (ATM) Personal Identification Numbers (PINs), is the de facto standard in some jurisdictions.

In the case of the US, social security numbers serve as a de facto identifier, whilst in New Zealand and Malaysia, true national identity cards have been in use for some time. By contrast, there is considerable opposition to the introduction of a National ID Card in the USA (for example, see "5 Reasons Not to Create a National IDS Card" http://www.aclu.org/Privacy/PrivacyMain.cfm). In Australia an attempt to introduce a similar national identity card came unstuck during the late 1980s [19]. France and Germany have both been using Health Smartcards for some years now.

In the wake of the public hysteria surrounding the failed "Australia Card", people's tax file numbers have come to serve a similar purpose. Birth Certificate, Passport or Driver's License numbers are alternative potential "unique" but non-

ideal identifiers. The Australian national Medicare number is not in fact unique, and doctor's practices, hospitals, pathology companies and so forth use incompatible identifiers and formats.

In an attempt to progress towards a UPI, in 2002 the NSW State Government commenced the rollout of a local government (regional) UPI, which was later expanded statewide. Choice of UPI was left to individual Area Health Services, but was essentially random-number based. It is interesting to note in passing that in this State-based UPI rollout, an earlier proposal to use a "health smart card" as a means of increasing consumer control over information was dropped [20,21].

For the Diabetes Field trial (Section 5), the small number of participating doctors and patients meant that the (Divisional) random-digit identifiers generated previously for the IDGP Diabetes Program sufficed. By contrast, The Canadian Institute for Health Information considered two possibilities (i) expansion of an existing number versus (ii) using a biometric identifier.

Ultimately, the problem with randomly assigned digits, just as with credit card numbers or PINs, is loss or theft. A *truly* unique identifier is not possible with the assignment of random digits, but *is* possible if patient biometrics are incorporated. Generally speaking, the most secure systems are based on a threefold approach, namely by utilizing (a) something we are (a physical characteristic or biometric), something we possess (such as a physical key or

token) and something we know or (for example, a password or PIN) [22]. Focus on (a) would ensure both uniqueness and permanency, and thereby enhance patients' security and privacy.

5. Smart_ID Field Trial

Responsibility for healthcare in Australia is spread across Local (regional), State (NSW in this case) and Federal governments. The Federal Government oversees primary care (community health, aged care, nursing homes and the like), while State Governments look after secondary health care (hospitals).

The conclusions reached in this Section are drawn in large part from a 3-year (2000-02) Smart_ID R&D Project undertaken in conjunction with the Illawarra Division of General Practice – IDGP, and funded by the Australian Government under its Strategic Partnerships with Industry Research and Training – SPIRT – scheme (nowadays known as Linkage Grants). Divisions such as IDGP correspond roughly to Local Government areas.

The collaborative Smart_ID Project built upon a pre-existing relationship between the University and the industrial partner – IDGP [23]. More specifically, it expanded upon an IDGP Diabetes Program which commended at the end of 1999, and involved collecting patient HbA1C, cholesterol, triglyceride, weight, height and blood pressure from individual doctor's surgeries, and subsequently

storing this information back on a centralized server at the Division. The underlying premises of this Project were:

(i) data needed to be not only accurate, but also comparable,

(ii) the system needed to be automated, and

(iii) patients could move around between surgeries, in the knowledge that this data would follow them.

By the end of the 12-month trial, a total of 40 General Practitioners (doctors) and 540 (type-2) diabetes patients were enrolled in the Program. Of these, 6 General Practitioners – GPs – and 13 patients proceeded onto the Smart_ID Field Trial. It should be noted here that the latter group were essentially computer-literate and pro-technology.

To place this Smart_ID Project in context, it should be emphasized that IDGP was primarily interested in issues to do with access – namely currency, portability and ability to be informed. These were seen as facilitating the movement of patients around the region, and providing them with a means for accessing their own medical (diabetes) records.

5.1 Preliminary Surveys

In between the 1999 introduction of the IDGP Diabetes Program and commencement of the 2002 Smart_ID field trial, both GPs and patients were surveyed [13,24]. Basically, both groups indicated a willingness to use smart

devices, for relevant organizations to also have access to patient Electronic Health Records, and moreover for biometrics to be incorporated onto the smart device. Furthermore, approximately half of surveyed patients believed that UPIs would lead to improved health care, while two thirds expressed concern over their associated risks – namely the possible compromising of privacy and security.

5.2 USB iKeys *versus* Smart Cards

Smart devices – such as smartcards and iKeys – offer a limited amount of on-board storage (encrypted and/or compressed as necessary), and can provide ready access to remotely stored EHRs in non-emergency situations [25]. Furthermore in emergency situations – such as cardiac or diabetes episodes – vital patient data can be read on any suitably configured computer (i.e. smartcard reader or even more readily – inbuilt USB port).

In the past, smart cards have been used primarily *within*, rather than *across* organizations (such as hospitals, health insurance companies and medical groups) [26]. One factor that has hindered the more widespread adoption of smart cards in a health environment is the plethora of (incompatible) protocols and Application Programming Interface standards; another is that "more research is needed on privacy and security". Nevertheless, 80 million smart cards are currently being used within Germany's healthcare system [27]. Once again, the

observation is made that “of course privacy, technology, legal and cost issues must be addressed before such health-related applications become widespread.”

Storage of complete medical histories and vital records on smart cards has been advocated for Hong Kong – more specifically, record management, security and authentication, and clinical alert system [26]. This is in direct contrast with the Smart_ID Project, where the smart device was used *solely* as the secure access mechanism to medical records stored remotely on a secure server.

In the future we could witness the merging of smart device and internet technologies, thus enabling anywhere/anytime/anyplace access (in order to cater for increased patient mobility). Significant technical challenges remain however: “the exchange of electronic medical data requires the establishment of a canonical medical structure with supporting data abstraction processes, to provide unified views of medical information” [26]. Moreover, the social, legal and ethical obstacles are even more daunting, as outlined earlier. Imagine a scenario, for example, whereby a citizen’s driving record could be updated within minutes of committing a parking violation, say, where smart devices are used for authentication: “such an application could present some interesting legal issues, depending on which country or state issued the license” (sic) [27].

An even more pertinent scenario is the use of smart devices for authorization in a health care setting. More specifically, “configuration for dialysis equipment, as

well as medical information, could be stored on smart cards and inserted into a smart card-enabled dialysis machine anywhere in the world. Of course, privacy, technology, legal and cost issues must be addressed before such healthy related applications become widespread" [29]. Once again, we come up against social, legal and privacy issues potentially overriding any technical ones.

Over the past few years, the Australian Health Insurance Commission – HIC – has been conducting a "Digital Certificate" scheme, whereby participating GPs are issued with unique (random number) identifiers, residing on either smart cards or USB iKeys (most in fact have opted for the latter in recent times). We chose iKeys in preference to smart cards for the Smart_ID Field Trial; both media exhibit similar storage capacities, (PKI) security capability and access times. Since most modern-day computers come fitted with USB ports, this obviates the additional cost associated with external smart card readers, despite the cost per card being considerably lower than USB iKeys if purchased in bulk. We selected the same type of iKey used by the HIC (Rainbow Technologies iKey1032 http://www.rainbow.com/ikey1000_sw.html) for our project. We further observe that USB iKeys are becoming more accepted by the general public, as general-purpose, portable storage devices – in fact since the completion of the Smart_ID Project, they have become ubiquitous in the computer industry [28].

Similar issues exist regarding loss or theft of either type of smart_device (i.e. re-issuing of smartcards/iKeys). On occasions during the Diabetes Field Trial,

patients forgot to bring their iKey with them to the doctor's surgery. There is the additional problem with either device of a "plan-B" backup – what happens in the case of a collapsed patient, for example? If they have their Smart Card or iKey on their person, then it may be feasible to insert this device into a nearby computer, provided the smart_device is not password protected, especially if a biometric has been encoded onto the device.

5.3 Field Trial Setup

A communications link is established initially between the doctor's computer and the IDGP server via dial-up modem. Programs running on both machines then enable the transfer of patient data. This does not happen until firstly the GP, followed by the patient, insert their respective iKeys into the GP computer USB port. Access to a specific patient's diabetes record is granted only if *both* doctor and patient have been previously enrolled in the Diabetes Program (which, by the way, facilitates movement of patients between different doctor's surgeries). Note that no patient data is stored on the iKey itself – it is simply used as the secure access mechanism. In earlier, similar (cardiac) trials at other sites, smart cards rather than iKeys were used (http://www.smartcard.com.au).

The software running on the GP's computer searches for new data entered into `Medical Director` (the de facto case management software package used in the Illawarra region), thence transfers the patient's record to the IDGP server. A

web interface has also been developed which enables patients to access this data consistent with the NSW (State) Government's Health Clinical Management Guidelines for type-2 diabetes.

Thus in this 3-year Smart_ID project, the technical solution revolved around the use of USB iKeys to access patient records stored remotely from the doctor's surgery, on a central data repository [30,31]. This resulted in a more comprehensive diagnostic tool than that afforded the doctor by way of `Medical Director` clinical software running on their local PC alone.

5.4 Field Trial Results

Now whilst the use of iKeys *per se* proved relatively straightforward, it became apparent that the overriding factors affecting widespread adoption are more likely to be non-technical: the impact on GP workflow processes, Electronic Health Record formats, Unique Patient Identifiers, and more especially privacy legislation impact significantly in this regard [25].

Perhaps an even more significant outcome from this Smart_ID Project was the development of a technological model to define remote, ubiquitous access to EHRs [32].

Despite some technical and operational glitches early in the 2002 Smart_ID Field

Trial, coupled with the low numbers of participants, we were nevertheless able to draw some significant conclusions, these being:

(i) both GPs and patients agreed that the Smart_ID system had the potential for improving information management in medical practices *(all 6 GPs and 20 patients surveyed)* [30,31],

(ii) the use of iKeys did not significantly impact on consultation times *(10 → 12 minutes typically, the additional time being that necessary to load the Smart_ID System)*,

(iii) all expressed a preference for iKeys over Smart Cards (Section 5.2),

(iv) patients viewed computer-based medical records as being an essential technology for health care in the future; likewise the adoption of a Unique Patient Identifier *(roughly half of the GPs and patients surveyed prior to commencement of the 2002 Diabetes Field Trial – [13,24], respectively)*.

Videotapes of consultations revealed that use of the iKey engendered more discussion between GP and patient, since it allowed access to remote patient data not normally available when a patient visits a different doctor from their usual GP (but who nevertheless is also registered in the Illawarra Diabetes Program).

Doctors were less enthusiastic than patients, with non-participants citing lack of available time to be trained in system usage, and participation in enough projects

already (sic), whilst nevertheless expressing confidence in using computing technology in their medical practices. The key consideration from a busy GP's perspective however is the impact on consultations – time is money, after all (i.e. efficient workflow processes). Patients were more enthusiastic, but recall that only computer-literate members of the public participated in this Smart_ID Field Trial.

Lastly, the effectiveness of the Smart_ID system used in the Field Trial was evidenced by an unexpected side benefit: some patients who accessed their diabetes records on the IDGP website were able to report back to their GP that certain entries were in error. Not surprisingly then, patients on the whole regarded the iKey as an empowering tool.

Now to the question of access, which we can view from three different perspectives, namely (i) currency (ii) portability and (iii) ability to be informed, as previously discussed. By <u>currency</u> we mean detection of a registered iKey in the USB port of the consulting doctor's computer. In other words, access to Electronic Health Records stored on the remote server is only possible while the iKey is connected. <u>Portability</u> refers to the ability of patients to move around the region and consult with *any* doctor registered with the Diabetes Program. <u>Ability to be informed</u> relates to a patient's right to determine who is granted access to their EHR. By requiring *both* iKeys to be inserted in sequence before access is granted, patients are able to monitor doctor(s)' access. In other words, the

process is self-informing – and once again empowering from a patient's perspective.

To sum up, the two critical findings from the Smart_ID Field Trail were: (i) both GPs and patients agreed that Smart_ID devices had the potential for improving information management in medical practices, and (ii) the use of iKeys did not significantly impact on consultation times. This experience of a certain (computer-literate, pro-technology) cross-section of the public should be contrasted with more global public attitudes: only between 10% [30,31] and 42% [14] previously indicated they would be in favour of using biometrics for accessing Electronic Health Records (and in the case of the latter, 25% for both biometric and smart_device together; and 22% for smart_device only).

5.5 Relevance to TeleMedicine

The unifying concept of this TeleMedicine book is that new technologies have not been widely adopted because of human and organizational factors. In this book Section – 3. Technological Innovation in TeleMedicine and eHealth – we consider questions such as the role that innovation plays in successful telemedicine, the proof needed for healthcare professionals to embrace new technologies, and the actions and structures that can promote high acceptance of new technologies in health care organization (we will revisit these issues in Section 7). Suffice to say at this stage that as a result of the Smart_ID Project,

we have developed a technological model which enables the secure, remote and ubiquitous access of EHRs [32].

6. Future Directions

The access mechanism commonly employed with both smart cards and iKeys is user name/(encrypted)password, similar to the Personal Identification Numbers (PINs) used on more primitive, yet ubiquitous, magnetic stripe Automatic Teller Machine (ATM) cards. PINs are essentially random digits, whereas passwords are alphanumeric, with security further enhanced by use of PKI.

The advantage of biometrics is that they are universal (everyone has them), unique (no two people have exactly the same characteristics), permanent (they don't change over time) and collectable (readily quantifiable) [33].

Now rather than use (random) digit identifiers, patient biometrics have the potential of facilitating a much more secure access mechanism – in other words by comparing freshly captured biometric identifiers with those stored on the smart_device. This potential is due to the fact that we always carry our biometric identifiers with us – they cannot be forgotten, lost or stolen (and subsequently misused by an impostor), as can cards [33-40]. Biometrics do not eliminate the possibility of a security breach, but they do lead to systems which are difficult to compromise.

Incorporation of biometrics onto smart_devices offers another potential advantage, in relation to lost or misplaced iKeys (or smart cards). In the eventuality of a patient losing consciousness, it may be possible to compare (certain) stored biometric characteristics with freshly captured versions. This is feasible for fingerprints, iris, hand geometry and perhaps face, but obviously not for voice or handwritten signatures. However the responsible hospital staff/health professional would need to (a) be able to access the health computer system, and (b) override any inbuilt security on the iKey (smart card).

Some vendors have opted for so-called "two-factor authentication". For instance, WiseKey combine iris recognition with public key cryptography (PKI) (http://www.wisekey.com/pages/health.htm), whereas ActivCard combine PKI and biometrics (or digital certificates – e.g. one-time password) to provide "true security and portability" with their smart card (http://www.activcard.com/activ/services/library/ehealth.pdf). In the Parkinsonpas (Dutch Parkinsons) Project (http://www.prisma-eu.net/deliverables/SC2ehealth.pdf), biometric templates were stored in a smart card which featured an integrated (Siemens) fingertip reader.

In a report on the use of smart cards in the Canadian medical sector it was concluded that technical adequacy is a necessary yet not sufficient condition for adoption [41]. More critical was that an obligation be placed on patients to

actually *use* them – only then would we see the widespread adoption of such smart devices, and in due course advantages flow to the health professionals concerned.

The overriding considerations for both health professional and wider public acceptance of biometric systems are accuracy, efficiency, non-intrusiveness, confidentiality (such as on-forwarding of information to unauthorized third parties) and cost – in particular the amount of additional computer equipment needed to implement them. In regard to the latter, in-built microphones can be used for speech recognition, and commonly fitted peripherals such as web cameras can be used for iris and face recognition; handwritten signature and fingerprint recognition however require more sophisticated peripheral devices (graphics tablet and/or scanner, respectively), although some USB iKeys now come fitted with inbuilt fingerprint scanners.

This begs the question as to whether the field has matured to the point where biometrics can be effectively employed for secure access of EHRs. Industry proponents appear to take it for granted that it has; others, such as the American Civil Liberties Union (ACLU), err on the side of caution.

One industry observer has stated: "The biometrics industry needs to provide wide education on biometrics; for example, that verification systems cannot, in general, be used for forensic purposes, or that their civil liberties are not being

eroded or threatened. Until this is widely understood there will be public pressure against biometrics." [42]. The most active vertical market for biometrics is viewed as being healthcare. Moreover, healthcare providers in the US are being driven by the recently introduced Health Insurance Portability and Accountability Act – HIPAA – which mandates both the privacy of Electronic Medical Records and limits access to only those people authorized to view them (http//www.hhs.gov/ocr/hipaa). Biometrics are viewed as a key technology for achieving HIPAA compliance, namely by means of strong authentication of remote users over a network.

By contrast, the American Civil Liberties Union opposes the use of face recognition software at airports, due to its ineffectiveness and also to privacy concerns. The ACLU further observes that several US Government Agencies (such as Immigration & Naturalization on the US-Mexico border) have abandoned facial recognition systems after finding their performance failed to match claimed levels, with unacceptably high levels of both false positives and false negatives being reported (http://www.aclu.org/Privacy/PrivacyMain.cfm). Sydney airport, by contrast, used face *verification* rather than face recognition per se in their SmartGate system (i.e. fresh facial capture versus passport photo) (http://www.anu.edu.au/people/Roger.Clarke/DV/SmartGate.html). Some other airports have chosen alternative biometric techniques (e.g. London Heathrow & Amsterdam Schiphol have opted for iris scanning, whereas Kennedy, Los Angeles and Miami use hand geometry).

Apart from privacy and security considerations – and to an extent, cost – the bottom line from a consumer's (the public's) point of view, is accuracy and reliability. In relation to the former, accuracy rates vary with biometric type. False Acceptance and False Rejection Rates (FAR & FRR) are commonly used to measure accuracy. The most accurate biometric features are, in decreasing order: iris (0% FAR; 2% FRR), followed by fingerprints (0.001% FAR; 6% FRR), with both face and signatures being much worse [40]. By contrast, current biometric usage rates vary from fingerprints (39%), hand geometry (37%), speech (16%), face (7%), iris (4%) and signatures (3%) (*Economist* newspaper, September 2000). The ultimate biometric is most likely DNA, but at this point of time would be far too intrusive to be of practical use.

The other major impediment to the widespread adoption of biometric systems is lack of standardization – either formal or de facto (industry), although BioAPI (http://www.bioapi.org/BioAPI_home.htm) has been making inroads in recent times.

It should be emphasized here that it would only take *one* disastrous field trial to sway public opinion against using biometrics. The importance of pilot system trials cannot be overemphasized. Positive outcomes can include the resolution of potential interoperability problems, whereas negative outcomes (in other words, poor experience which doesn't match expectations) can set back the entire field

for decades. Indeed, an unrealistic buildup of expectations can be quite counterproductive (witness the effect of the dotcom crash in the early years of this century on the IT industry generally, or the perpetual non-delivery in the field of Artificial Intelligence [43,44]). To an extent, this has already occurred with regard to face recognition for airport security (see, for example, the Boston Globe of 18.7.02, reporting on the Logan Airport experience).

7. Conclusion

Now to return to the issue of lack of adoption of new technologies in eHealth (Section 5.5. Based on our experience with the Smart_ID System developed for diabetes patients and their doctors, we are able to draw some general conclusions in regard to such matters.

Firstly, a precondition to patients participating in the Smart_ID Field Trial was that they be enrolled in the Illawarra Diabetes Program. These diabetes patients were invariably computer literate and pro-technology. Furthermore, they were all favourably disposed towards the use of EHRs and UPIs, including in the case of the latter incorporation of biometric identifiers. Patients left the field trial even more favourably disposed, having had positive experiences of both the USB iKeys and the ability to view their own EHRs via a web browser.

Doctors enrolled in the Smart_ID Field Trial were likewise technically literate, and

most (but not all) were willing to undergo the minimal training required in the use of the iKeys. Impact on consultation times was considered minimal.

Both patients and doctors could see the benefits which flow from being able to access patient data during consultations – more informed and engaging discussions often followed as a result of this.

Since the field trial, the USB iKey System has been expanded to *all* doctors enrolled in the Diabetes Program in the Illawarra region (not just the 6 who participated in the Field Trial). Likewise, iKeys are subsequently being used to link patient data stored on the IDGP server to Diabetes Health Professionals connected to the Illawarra Area Health Service Local Area Network. In summary, the IDGP and IAHS both continue to advocate for the adoption of iKeys. Once doctors experience their ease of use and access to EHRs, they invariably embrace the new technology – in other words, they learn from their own (positive) experience. Fear of the unknown, and/or an unwillingness to change from the way things have always been done (in other words, inertia) can easily impede the adoption of new technology, unless the resulting benefits are immediately obvious.

Furthermore, we are not talking about a *radical* step up in technology here, but rather a simple procedure involving the insertion of an iKey in the computer's USB port, followed by accessing files stored on the remote server. Asking Health

Care Providers to take *too* big a leap with new technology could well be a deterrent to its adoption (i.e. taking them too far out of their "comfort zone").

Another point worthy of note is that use of USB iKeys is consistent with the Australian Government's Digital Certificate Scheme, by which participating GPs are issued with unique identifiers on either smart cards or iKeys. The long-term goal of the Health Insurance Commission is to facilitate on-line reimbursement of doctors thus registered. By extension, the Government could foster widespread adoption of such technology if financial incentives (i.e. rebates) were added to the mix.

Finally, publicizing successes such as the Smart_ID Project – both nationally [23,24,30] and internationally [2,13,25,31,32,40] – also plays a significant role in the future adoption of such technologies.

To return briefly to biometric systems – is the public willing to accept 95% (99%, 99.5%) accuracy? In practice, it comes down to a balance between security and accessibility to achieve an acceptable level of risk – more specifically, are patients willing to sacrifice some privacy for greater security? Operation & system integration are other challenges which if not adequately addressed can render biometric solutions unworkable in real-life deployment. Further, there are limitations due to background lighting for face/iris, background noise for speech, and so forth. It should also be pointed out that there is nothing to be gained by

combining different biometrics, since this leads to diminishing accuracy overall (the whole being *less* than the sum of the individual parts) [45].

So what are the key considerations for the acceptance and widespread adoption of this new technology within a health care context? In a nutshell, the best catalyst for acceptance would be successful practical demonstrations and field trials. To date we have established the viability of using iKeys (smart cards) for remote, secure access of patients' Electronic Health Records [31,32]. More specifically, we have devised a technological model for secure, remote and ubiquitous access of EHRs [32]. Further field trials are needed to confirm the benefits to be gained from incorporating patient biometrics onto such smart_devices [40]. Apart from providing a technical solution, it is suggested that biometrics could provide true "uniqueness" – in the sense of UPIs – for secure access of EHRs. Lastly, incorporation of biometrics has the potential for *enhancing*, rather than reducing, patient security and privacy.

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Using ICT to better support the fragmentary nature of healthcare

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Introduction

Patients are, obviously, central to any national healthcare service. As we live in an age where people are living longer, and demanding a better quality of life in terms of health throughout their lives, the demands placed on any healthcare service are therefore great. The financial burden on either the patients themselves or the government to keep patients in hospital or in institutions such as care homes for the elderly, the mentally impaired or others who require full-time care and assistance is great. Such care cannot, at present, be provided in their homes, although it is hoped that when or if technology is installed in our homes, this will allow the healthcare service to deliver the same (or better) quality of care but without the enormous costs involved. It is not, however, just a matter of financial cost. Involving us more in our own healthcare at an earlier age or stage has two advantages. One, being at home or, at least, as near to home as possible, has psychological advantages that positively impact on our mental, and thus physical, health. Two, there is the possibility that, as we feel more comfortable with the technology and/or our confidence grows in approaching healthcare professionals or health issues (many people fear both), we might take a more proactive role in our own healthcare and thus either delay the need for intervention or, at best, manage a potential problem away. It might be argued, however, that while those of us who work with computers regularly and are thus both confident and, it is hoped, competent with such technology, the same is not necessarily true with the general public, the very people the healthcare service aims to support. Technology is often viewed by those without such exposure as impersonal, adding to, not bridging, the communication gap between those engaged in the interaction. While such lack of empathy and personal contact might be expected, and acceptable, in, say, sending off a tax form to the relevant authority, in the case of healthcare we, as patients, expect exactly the opposite, that is, we wish to be treated with every sympathy and with due regard to our emotional as well as physical needs. We expect (although we do not always get) a warm welcome from those that we come into contact with in the healthcare sector, we want to be given sufficient time and attention to express our needs, fears and the like in the most supportive environment possible at a time when we may feel vulnerable and scared and in need of support. For the patient with little or no experience of the technological wizardry involved surrounding computers (and there are many more than we like to think), not to mention the technology of the healthcare world (scanners, probes and all manner of equipment whose purpose is not necessarily immediately apparent) and with the additional fear engendered by those with serious or potentially serious medical issues, the hospital, clinic or wherever can be a pretty scary place.

It is not, however, only the *patients* who are fearful of the seemingly negative impact of technology in mediating the dialogue between patient and healthcare professional; those working in the healthcare sector are similarly voicing their concerns with regard to the use of computers. This is, perhaps, somewhat surprising given that healthcare is, of all the professional activity, most likely to be 'technology-rich'. While healthcare professionals seem very keen indeed to have the latest scanner, imaging equipment or instruments (what surgeon would proudly claim "Yes, it's a very old model/tool that I use to carry out this complex procedure" when trying to reassure the patient that they are shortly to operate on !), there does not appear to be the same enthusiasm for using the computer in a similarly supporting role. Computers, in healthcare and elsewhere, are sometimes viewed akin to humans, and with the same human powers. The popular press seems to suggest that teachers, doctors and others might well find themselves out of a job in the not too distant future given the sophistication of the technology to do what has/had hitherto been regarded as activity only possible by humans. There are mutterings along these lines in the professions themselves, which might in part explain a reluctance to embrace computer-centred technology. Whether patient or healthcare professional, the computer is seen as something which can only negatively impact the personal contact that each expects of the interaction between the humans involved. It seems that for those of us engaged in promoting computer-supported interaction, we have much to do to persuade those involved that the computer, appropriately used, is as much of value as the other 'tools of the trade', so to speak.

Discussion of e-health is, as the above demonstrates, a complex business, as the editors of this publication rightly acknowledge. In their study of human factors at the beginning of this publication, they present a six-layer onion, with organisational learning and success, as the goal, at its heart. They argue that it is only by looking at each layer that we can hope to make sense of the whole, but that the complexity of the interactions makes this problematic. This chapter of the book encapsulates various aspects of all six outer 'rings' of this onion, namely that organisational learning and success is dependent on us exploring the cultural and institutional context, technological innovation, change management, actors, network and alliances and mental models with clinical perspective. As you will see from the seven sections of this publication, chapters two to seven are each devoted to discussion of these six rings of the organisational learning and success onion. Presented in this chapter is the technological innovation layer of this onion, although as you will see, this cannot be divorced from the other layers which together make their contribution to organisational learning and success.

Every country claims that the needs of patients come first, and the UK is no exception. The National Health Service (NHS) in the UK published its NHS Plan in July 2000 (1), saying that patients and people were central to its radical reform of healthcare and that although this included more hospitals and beds, shorter waiting times and improved care for older people, an essential element was that patients should have more power and information. The NHS Plan is permeated with words and phrases that emphasise the need to involve patients more in their own healthcare. Although it would seem difficult to see how patients could be anything other than involved given that it is their body/mind that is being seen, treated or managed, this suggests that patients are currently viewed more as 'cases' rather than as individuals, as people. That is, that they come in to the doctor's surgery with a problem, and that it is the problem, rather than the patient, that is being seen. While in some sense this is naturally necessary, as patients want the health problem 'solved' in some way, as in the case of, say, a broken finger being mended or a minor injury being treated, not all patients present things which might be seen as a 'problem to be solved'. Indeed, it might be argued that much cannot be 'solved' anyway; asthma, psoriasis, mental health conditions and the like do not, and cannot, go away and it is more that these need to be managed, as effectively as possible, by both the patients themselves (who are, after all, dealing with their healthcare day in and day out), and, on occasion, with the assistance of various healthcare professionals. However, healthcare is as much about dealing with a wide range of 'everyday' issues, such as helping a first-time mother with her new baby or helping someone deal with the death of a loved one. Whether borne out or not, there is a perception, at least, that doctors and consultants, in particular, are viewed by their patients as somewhat distant, over authoritative and dispassionate. Indeed, the word 'clinical' does not only mean 'relating to health' but also detached, lacking in empathy. Whether stated explicitly or implicitly, there seems to be a call for healthcare professionals to engage more fully with their patients, and to see them more as some kind of 'partner' in their healthcare rather than someone 'in authority'. Patients are somewhat in awe of doctors and, in particular, consultants and this is raises issues with regard to the patient/healthcare relationship.

The UK Health Service

It is first necessary to provide some background as to how healthcare is organised in the UK, as this varies from country to country. One vital aspect of healthcare in the UK is that for the vast majority of the population it is paid for not via private medical insurance but instead through the system of taxation. It is thus seen as 'free', in some sense, by patients as they do not need to pay for any treatment direct to either the local doctor/general practitioner or any other healthcare professional. Whilst patients may regard it as 'free', it is nonetheless extremely expensive for the government to provide, particularly in a country where the number of taxpayers is decreasing in relative terms, the population of those over 65 is significantly greater than in previous generations and the fact that healthcare 'solutions' such as drugs or surgery are now that much more expensive. In addition, patients expect and demand more of the healthcare services these days, and with the advent of the internet are much more informed as to the choices available. In other countries, both in Europe and elsewhere, patients can see a specialist/consultant in a hospital without needing to be referred there by their own local doctor, and may enter the health system directly at the secondary or tertiary care level of figure 1. In the UK, this is not possible; a patient must enter the system at the primary care level and first see his or her own doctor, known as a general practitioner, whose surgery/clinic is

normally located close to the home of the patient. As in many states in the US, there is little evidence that the healthcare system is moving towards "enabling less expensive professionals" (such as nurses) to do "progressively more sophisticated things", as Christenen et al (2: 106) argue that we should be considering if we are to use what they call 'disruptive innovations' to radically alter, with a view to improving, healthcare at both a local and national level. The local doctor/general practitioner is, then, a kind of 'gatekeeper' (3) to other services should these be needed. In the US this would correspond to managed care.

<< take in figure 1>>

The health service provided at this level is known, in general, as primary care. It is the responsibility of the doctor/general practitioner to refer the patient on to what is known as secondary care, usually a hospital, where more specialised equipment, and specialists/consultants are on hand. Where secondary care is unable to provide a solution, referral is made to the more specialised tertiary care centres, either by primary care directly or from secondary to tertiary care. As with any healthcare system, there are potential drawbacks, and these have implications for the speed and accuracy of the treatment both at primary and secondary care level. Referring the patient from primary care to secondary care normally involves a lengthy process of letter writing between the doctor/clinician and the specialist/consultant in the hospital in trying to book an appointment. The specialist/consultant in the hospital then has to contact the patient to tell them of the time and day of the appointment. It goes without saying that this is a lengthy process, and time, for those with serious illness, may be in short supply. The doctor/clinician is somewhat divorced from what happens from that point on and, given the problems associated with relying on a postal service (normally efficient enough, but the UK has suffered from postal strikes in recent years) to relay communication between consultant/hospital and patient, there is the danger of information either arriving late or, worse, not arriving at all. A patient referred to secondary care may have moved house in the time between first seeing their doctor/general practitioner and the first consultation with the specialist/consultant. Although this may seem trivial, cases have been reported in the media where this new information has not been conveyed, and that this has adversely affected the healthcare of the patients concerned. Patients themselves are unaware of the processes going on behind the scenes, so to speak, and so it is not difficult to see that they would not necessarily realise the importance of informing anyone of their change of address. Moreover, although they may consider reporting such information to their own doctor/general practitioner at primary care level, they would not know whom to contact at secondary care level as the name of the specialist/consultant or their place of work would likely not be known. It might be argued that the organisation of healthcare in the UK is not very patient-centred; once the patient presents themselves to the doctor/general practitioner at the primary care level, and it is decided that intervention at secondary care level is required, then the patient plays a relatively passive role in the management of their healthcare, or the processes associated with it.

<< take in figure 2>>

Patient care pathways provide a useful insight into many of the factors that affect the perception of the standard of service and care that the patient may receive. Figure 2 might represent a typical patient care pathway for a patient presenting to the doctor/general practitioner with chest pain. In the UK, the doctor/general practitioner will refer the patient to the cardiologist. The referral is made in the form of the "referral letter", which should include a medical summary of presenting symptoms, history, relevant existing conditions, drugs, results of tests and any other pertinent information. However, information content may be very limited. In this case it is the patient that moves around the system. At the first consultation with the cardiologist, it is likely that the tests necessary to make an unequivocal diagnosis, stress exercise test, echo-cardiogram, will not have been performed and the information will not be available. The patient must return for these and return on a further occasion to see the cardiologist. Only at this point is there the information that can be used to make the diagnosis. A positive exercise test will result in angiography and likely treatment such as angioplasty or CABG.

The patient care pathway highlights where delay is experienced, which are a significant cause of dissatisfaction for patients. National Service Frameworks in the UK (NSF - Coronary Heart Disease) outline targets for specialities. However, the analysis of figure 2, clearly highlights the distinct lack of information that is exchanged between the doctor/general practitioner and cardiologist. Even when the patient returns from hospital following treatment and is rehabilitated, the doctor/general practitioner may have little information on the procedures that were carried out and on the management that must follow to maintain the patient. It is the role of technology and ICT to improve what information is gathered, where it is gathered and how it is exchanged between the key players responsible for the management and care of the patient. The structure of the health service in different countries differs, often in quite fundamental ways. However, the pathway of care can be seen to offer assistance in many ways and offers an important analysis tool for considering factors. It provides an abstract view of the desired pathway against which existing services may be compared and changes may be identified. It also offers a tool that allows alternatives to be considered. This may include changes to the pathway of care experienced by the patient, steps may be eliminated, added or replaced. New pathways may be created, especially those which might improve gaining, management and movement of information.

Current Role of Technology

Information and communication technology (ICT) can (and does) play a role in both primary care and secondary care. And, with the move to involve patients further in their care, patients themselves may well, in the future, make their own contributions in some way, both passive by searching information or active by contacting health workers perhaps from their home computer. That information systems are becoming increasingly more sophisticated is uncontested. Indeed, Rodger and Pendharkar (4) describe a variety of fascinating technological developments used by the Department of Defense in the US. However, whether it is sophisticated, which somehow carries with it the assumption that it is somehow 'better' or, at least, 'good' in comparison to whatever was in place before, is of little value, particularly in terms of healthcare. As a report by Payton and Brennan (5), on a phone-accessible web-based computer network that was developed for the use of those caring for patients suffering from Alzheimer's disease, demonstrates, an 'unsophisticated' response answered the needs. It revealed that what carers actually wanted was "someone to converse with and share ideas" (page 88) and that access to an encyclopaedia into the disease or even a decision-making utility was not regarded as useful by this particular set of users. This has important implications for those developing information systems, namely, that when we are ill or request intervention of one sort or another from healthcare professionals, we do not ask for sophistication but rather that we receive an appropriate, timely and accurate response. They want such a response to be personal, sensitive and with due regard to their emotional as well as physical needs; a tall order indeed for healthcare professionals working in an emotionally charged and often fraught environment.

Whatever the role that technology will play in the modernisation of the NHS or any other global, national or local healthcare system, none can doubt that it is perceived as vital to its success. Quick to grasp this have been the technology multinational companies, eager for business. Huge multinational organisations involved in producing computer technology for industry, particularly in a financial climate where competition is fierce and there has recently been a significant downturn in business, are keen to promote any service as, naturally enough, they are in the business of selling technology. They would understandably claim to be in the business of improving the health of patients, although the cynical among us might recall the very many horror stories of extremely expensive information systems that not only took far longer to build than their designers said at the outset but also that they did not deliver what their customers expected; some did not even work at all and had to be shelved. That said, the future of technology looks bright, as illustrated in the following story. Recounting the speech made by Bill Gates, founder of the world's most well-known software company, Microsoft, Hawkes (6) reports that Gates, who is currently actively seeking to develop new products for the NHS in the UK and likely elsewhere, tells a story of how things might be in the future, technology-led and managed, health service. In this wonderful technology-enriched future, a businessman is knocked down by a cyclist, but is not so seriously injured that he cannot use his mobile phone to gasp "Call my doctor now !". The mobile phone, upon recognising his voice, dials Dr X's surgery, and the female receptionist somehow verifies his identity, locates him (from the mobile phone signal) and calls an ambulance. While on his way to hospital, the

receptionist sends his medical records electronically, so that the Accident and Emergency team have them to hand upon his arrival. The businessman's own doctor calls up the record of the treatment online, offering his patient reassurance that he has had the best possible care and treatment.

As Baldwin et al note (7), the businessman has been very lucky on at least four counts. One, the accident happened during normal opening hours of the surgery. Two, the technology worked perfectly. Three, the ambulance was able to reach the spot quickly. Four, the patient records were correct and up to date. This seems to be an excellent example of how such technology could be successfully used. However, for such a scenario to play out, it would seem that the context in question is not beset by the practical difficulties that, we suggest, permeate our professional and personal lives. This scene is based on the premise that either such accidents happen only during normal working hours (while we have no research to back up our view here, common sense leads us to conclude that this seems highly improbable) or that in this new NHS, the clinic/surgery of our local doctor is open 24 hours a day. Given budgetary and other constraints, clinics/surgeries of local doctors in the UK are open for only a few hours in the morning and a few hours in the late afternoon/early evening Mondays to Fridays (and not at all at the weekend), for the most part. It would also be difficult if not impossible, at least for those of us who use technology extensively, to imagine an environment where technology worked perfectly, all of the time. Indeed, some would likely be grateful if it worked reasonably well, some of the time ! Until the advent of technology which functions so wonderfully, relying on technology alone should not form part of any vision of a healthcare system, surely. Ambulance services in many countries in the west are very good indeed, so perhaps we do not need to suspend our disbelief too much when envisaging the speedy arrival of an ambulance. That said, however, the patient must live in a reasonably urban setting; ambulances cannot respond so quickly (if at all) in a rural one, and it is not peak time. Luck must also play a part; good weather conditions, and little traffic in this scenario. Correct and up to date records is yet another aspect of the world of work which is a worthy goal but rarely (if, indeed, it is possible) to achieve. However careful, professional or whatever we are with administration, errors are made and/or things are not entered in a timely fashion. Imagining ourselves as that businessman (we are by nature, fairly selfish; something well understood by image makers enticing us to buy), it is easy to see how we might be seduced by such a picture of healthcare in the future. The message to the taxpayer/government is, then, invest heavily in (very expensive) technology and we will all get the right treatment at the right time and, it would follow from this, though of course not explicitly made, live a long, healthy and happy life. On a slightly less optimistic note, we see that some things in life will not change that much according to the example given. The doctor is male. The receptionist is female. The patient, chosen as someone worth saving, is a businessman. There is a crumb of comfort in this, however; we will not need to suffer the mental anguish associated with the task of altering our mental models of the stereotypical healthcare professional or who is valued more highly in our western society.

While there is plenty of information about healthcare available in print or, increasingly, on the internet, when faced with a healthcare issue which requires intervention, in the vast majority of cases, today at least, we need to deal with a healthcare professional face to face. The importance of the doctor/general practitioner in primary care is clear; it is, at least in the UK, the first port of call for the patient. Although the appropriate response may not require further intervention, the doctor/general practitioner and (normally) specialist/consultant is key. For the patient, who may well have built a good relationship with their doctor over a long period of time, being referred to a specialist/consultant in a hospital is not without its difficulties. Among these is the fact that the patient has never met the specialist/consultant; building a new relationship with a stranger is, for many, not easy. This is made more problematic by the fact that they are probably very anxious or upset, and thus not at their best in terms of expressing themselves well, clearly or, importantly, accurately. Yet the value of that initial visit depends not only on what the specialist/consultant knows about that particular illness or disease but on the quality of the information provided by the patient. And patients, naturally enough, do not necessarily know what is, or is not, relevant information which would help the specialist/consultant in their diagnosis and subsequent treatment or care. One of the most vital aspects of effective and efficient care is an accurate (as is possible) record of patient care up to the time when the specialist/consultant sees the patient. It is at this time that the specialist/consultant makes the vital decision as to what treatment is or is not appropriate, and when this needs to be carried out. The decision(s) made at that time are crucial to the patient's subsequent care and health, and it is clear that the knowledge and information available to the

specialist/consultant needs to be as accurate and as full as is possible. As Summerton (8) notes, inefficiency and/or inaccuracy can adversely affect not only prognosis but also the nature of any intervention(s), and the earlier those choices (that is, decisions) are made, the better.

Such information is stored in three (at least) different places. One, informally, by way of the knowledge and experience gained by the doctor (and/or, perhaps, another clinician in the primary care surgery/clinic, such as a nurse) who has been involved in the care of the patient up to that time. Two, formally, by way of the records that are kept in the primary care surgery/clinic, which in many places, are still kept only in handwritten form. Within primary care in the UK, computerisation is almost 100% and there is a high level of use of electronic records within the consultation. However, secondary care is not computerised to this extent, and almost all communication between primary and secondary care is by paper. Three, informally, by way of what the patient knows about their own health, history and experiences. As described earlier, the information currently available to the specialist/consultant when meeting the patient for the first time is limited to only two of the three sources available. One, formally, by way of the information that is forwarded by primary care and which is sent before (hopefully) the patient arrives (although in many cases this may be limited). This is commonly known as the "referral letter". Two, informally, by way of what the patient knows about their own health, history and experiences. Gaining information by way of only these two sources means that there is the potential for a breakdown (at worst) or a lack of richness in information-sharing between those working in primary care and those working in secondary/tertiary care, and, vitally, between patient and healthcare professional. Effective communication both *amongst* healthcare workers and *between* healthcare workers and their patients in both primary and secondary care is vital. Information in the current NHS is stored in various places and access is restricted; there is no central, complete, patient record that is accessible to all healthcare professionals at the various levels of care. There is also no mechanism for allowing the patient to interact both with their local nurse and/or doctor/general practitioner (at primary care level) while at the same time engaging with the specialist/consultant (at secondary/tertiary care level). At the same time, there is a reluctance for primary care to gain diagnostic information on the condition and any such tests are deferred to the hospital. It is not unusual for these tests to be performed *after* the first visit to the specialist/consultant, restricting further the knowledge/information that could be available. The knowledge/information that the specialist/consultant has to hand during the first consultation is shown in table 1 below. Also shown is what is *not* currently available across the healthcare sector in the UK to assist the specialist/consultant in their decision-making:

Knowledge/information currently available to specialist/consultant
• A brief letter of referral from the doctor/general practitioner • Information gleaned from the patient during the consultation
Knowledge/information that specialist/consultant does *not* have
• Full, formal written/other patient record from the doctor/general practitioner • Information gleaned from the doctor/general practitioner other than that contained in the formal written/other patient record • Information gleaned from any other healthcare professional (such as a nurse) who has been engaged in the care of the patient
Knowledge/information that specialist/consultant *may not* have
• Information from diagnostic tests • Information from previous visits to the hospital

Table 1: information available at the specialist/consultant <-> patient consultation

The AIDMAN Platform

In this chapter we describe a clinical ICT system called AIDMAN that has been developed and is now successfully used in the UK. The system is designed to re-evaluate the relationships that exist between all sectors of health care and, by use of ICT, can provide the third, vital, source of information lacking in consultations that are not tele-mediated. The 'virtual' consultation is able to bring together patient, health care professional from primary care and the consultant/specialist. In this scenario, the patient may bring knowledge of symptoms and previous history, the primary care healthcare professional brings informal knowledge of the patient gained from significant period of care of the patient up to that time, and the full formal, patient record held by the healthcare professionals at primary care level. AIDMAN (Advanced Informatics Distributed Medical Access Network) was designed to offer the patient the advantage of a 'virtual' consultation (9, 10, 11, 12, 13, 14). Face-to-face consultation offers particular advantages over other channels of communication, and although AIDMAN is in essence a clinical ICT system involving video-conferencing, its success has come by obtaining diagnostic information at the primary care level, and forwarding that information, such as high definition images, ECG, and ultrasound, in advance of the consultation. Using a computer based video-conference system (Proshare V5.2) also enables shared access to data applications and other peripherals or medical systems that might be considered useful in presenting clinical data during the consultation. AIDMAN has been designed to be communication technology independent and in the UK uses ISDN, but may easily use a network connection in its place. Within the project, satellite technology was evaluated to determine its capability to support web-based tools and video-conferencing; vital if the infrastructure in a particular region or country is not able to provide the links required by more conventional means.

<< take in figure 3>>

Part of the novelty of the approach is that much of the healthcare is nurse-led, rather than doctor/general practitioner-led at primary care level and it brings together the isolated 'islands' of knowledge and information held by both the patient and healthcare professionals involved in their care. During the consultation, the patient has at their side a medically trained person; this person can therefore use their hands or nose to provide the information gained by way of touch and smell, and can also operate the camera should the specialist/consultant wish to view a particular aspect of the body in order to aid diagnosis and determine the extent and severity of the problem (see figure 4). In this example, the patient has had leg ulcers for some months and there is no healing. The district nurse (right), will have visited the patient's home on a regular basis in order to change dressings, etcetera, and established a rapport and trust. Having the same district nurse in the consultation gives the patient a sense of support, and the clinical knowledge built up by the nurse can facilitate the consultation; the nurse can answer questions succinctly and fully and other aspects of the clinical background can be included. The consultant and nurse, together with the patient, would use the pre-intervention tele-clinic to agree the procedure to be carried out, in this case to operate on the vein. They would also describe the forthcoming process to the patient. The post-operative tele-clinic is used for follow up and to deal with complications. One of the major benefits of this collaborative approach is that when complications are detected, they can be dealt with much more quickly.

<< take in figure 4>>

It is important to realise that the AIDMAN system is a total approach that is based on the use of technology to support health delivery and communication between all key players. Although video-conferencing is used to support the virtual consultation, high definition images, reports, results from tests, shared access to data applications and other peripherals or medical systems might be used at any time during the consultation to present clinical data to either the medically-trained person at

one end, or the specialist/consultant at the other. It is an end-to-end solution and impacts on process at each stage of the pathway of care. Figure 5 shows a screenshot from a typical tele-cardiology session with both ends viewing the result from a stress exercise ECG test and accessing the clinical notes through the general practice database in order to review the drug therapy. The example highlights how the video-conference window is shrunk to a small size as the session becomes an exchange of information.

<< take in figure 5>>

Figure 6 shows how the pathway of care for cardiology might be modified by the use of technology. Stress exercise ECG testing is performed locally. An electronic referral, which would include the ECG report, and any other relevant medical history us forwarded to the cardiologist. The cardiologist now has the information that allows diagnosis to be made and a virtual consultation can be scheduled on the basis of need and urgency. A severely abnormal test might result in a virtual consultation within days, otherwise it would be scheduled as normal priority, whereas should the ECG be normal, no consultation would be needed. It is also clear that the first outpatient appointment in the original pathway of care is eliminated. Estimates of the number of patients referred inappropriately to the consultant can often exceed 50%, by having information these may be eliminated. The most significant difference is the increase in the flow of information between each sector of healthcare. Also note that management information is bi-directional, which reinforces the new model for health care structure. The ICT allows key health professionals from all sectors to collaborate, and bring each of their specialist skills to the problem. Here the pathway of care has been used to show the effect of altering the position of a test, the order of processes and the introduction of new flows of information. Eliminating half of the outpatient appointments and removing 50% of inappropriate referrals, the new pathway of care could reduce the number of appointments by 75%.

<< take in figure 6>>

Communication technology is general and TCP/IP networks are used. However, satellite links have been tested to successfully deliver to remote regions of Greece and, more recently, to cruise ships in the Mediterranean as part of the Medaship project. AIDMAN was initially set up to investigate the provision of digital telemedicine in an area of the world where patients find themselves remote from consultants/hospitals in some way, in this case, four hospitals in Greece; one in the capital, the KAT Hospital in Athens, and the other three in healthcare centres in Corfu, Mykonos and Mytilini (all 'remote' islands off the coast of mainland Greece). Its use in the UK has also been investigated. In this case it has been introduced in Chorleywood Health Centre, close to London and four neighbouring hospitals. Figure 7 illustrates its application and use in the primary and secondary care sectors at the current time:

<< take in figure 7>>

The major difference between the UK and Greece is that the AIDMAN system in the UK is not serving remote or rural communities and thus, for success, the system must be shown to deliver extra benefits to the patient other than overcoming distance, time and travel. The benefits for the rural community are well known, with many successful projects such as the AFCAN service in Alaska, the Centre for Telemedicine in Tromso, Northern Territories network in Australia, and UC Davies, in California, to name a few. The goal for changes to any health care delivery system must be better health outcome for the patient. If at the same time it makes it more convenient, improves access, reduces cost, then these are extra benefits. It may be argued that reducing costs means that more services can be afforded, and so the global health system benefits, and this is a good thing. Such systems can provide access to health systems for those that would otherwise have severe difficulty otherwise. Many telemedicine programmes are established to serve the needs of remote communities that are isolated and may be cut off due to weather conditions for weeks.

Such communities are often small and cannot support even a full-time doctor, and instead may have a nurse. For these situations, telemedicine may be used to support the local health professional in the diagnosis and best management of the condition. The intention would be to keep the patient in the community and to avoid travel, which would be expensive and may not be possible.

These projects have experienced an increase in the type and use of diagnostic equipment that is used and supported in the remote location. Digital equipment to perform a wide variety of tests is available and more are released on the market each year. Costs are also falling. Digital equipment for ECG, blood pressure, temperature, SpO_2, digital images, retinoscopes, ophthalmoscopes, ultrasound, spirometry and stethoscopes are available and affordable. The information from these devices can be recorded and forwarded to whoever requires it. In the AIDMAN project, the initial design for the virtual workstation was based on a Pentium II machine and includes desktop video conferencing (Proshare Version 5.2), a digital video camera for simultaneous analogue video and high resolution digital still image, flat bed scanner, soundcard and hands-free speaker phone. Figure 8 provides an illustration of its architecture:

<< take in figure 8>>

Many consultants appreciate diagnostic information in advance of the consultation, so that they can consider their diagnosis and then use the time with the patient more effectively. They also have the opportunity to ensure the quality of the information and that it is complete. This allows them to be able to request further information before the consultation. The system can access data from sources such as digital images, ultrasound, ECG or digital or digitised X-ray or CT-scan for use in the consultation. These can also be transmitted by other means in advance, for example, attachments to email or DICOM. There is, naturally, scope to install all manner of other diagnostic equipment in order to support the interaction between the patient/medically-trained person and the consultant.

The technology described here is unique in that it combines both 'store and forward' and 'real-time video' to bring all of these together, virtually speaking, by way of tele-consultation.

Experience with AIDMAN suggests that there are many benefits that are not currently provided by way of the traditional management of healthcare. They may be physical in nature, or more psychological. The benefits not only for the patient but also for healthcare professionals more generally are now outlined.

For the patient:

- They are seen quickly on an as-needed basis.
- No time is wasted if there is a negative result.
- By the end of the tele-consultation, they know whether, or when, they will be referred; the decision is made at that point.
- The advantage of being diagnosed both quickly and with minimum disruption to everyday life and work.
- No need to wait (and worry) about when the letter from the hospital with an appointment will arrive.
- The patient has 'met' (in a supported manner) the specialist/consultant, and has started the initial, important, process of building a relationship with the person who will play an important role in their future treatment and care.
- The patient has the opportunity to ask questions ahead of any face-to-face meeting with the specialist/consultant. This helps to manage their expectations and reduce anxiety about the unknown, that is, what is likely to happen.
- The patient can be given advice on preparation for a forthcoming procedure which may involve co-operation with the local health professionals.
- Changes to current medication and care can be implemented.

- As the patient is sitting in a familiar clinic, with a familiar doctor/healthcare professional, the psychological and physical trauma associated with the subsequent visit to the specialist/consultant is alleviated.
- It may help patients to better understand consultation *before* they undertake it, and thus to better prepare for it, as well as to help to 'de-mystify' what is, to many, the unknown processes involved in their healthcare.
- It provides added reassurance, as they have been closely involved in the dialogue between the doctor/healthcare professional and the specialist/consultant, and can thus have confidence that both share a common view of their care and treatment.
- Management of the case is negotiated and agreed by all parties, that is, consultant, doctor and patient, thus the potential to make consultation more effective for all participants.
- It may help change the current perceptions that patients have of healthcare, namely, that they are relatively passive participants in the process. This brings with it the notion of 'advocacy'. Tele-consultation is a physical (at least) demonstration of the central role that *they* play in the process, and that they are (or should be) *active* participants who engage in the management of their own health.

For the specialist/consultant and the doctor/healthcare professional:

- They are in the same room (virtually speaking) at the same time; with the patient.
- It is interactive; the consultant and/or doctor can ask the patient as many questions as is necessary to get the information needed to make the correct diagnosis and determine the most appropriate management.
- As full a history as is possible is available from the patient, the health professional (doctor, nurse, or other) and the medical records.
- The patient may feel or be unable, or unwilling, to explain their symptoms or feelings. The doctor/healthcare professional, (who will have had a longer and closer relationship with the patient), will thus have greater insights into the patient with regard to both their physical and mental state which may be of use to the specialist/consultant.
- Diagnostic information has been sent in advance of the meeting with the specialist/consultant so that an initial diagnosis can be made, which permits prioritisation of seeing each patient, and saves significant time within the consultation.
- The opportunity to call up/bring in new information as the tele-consultation progresses. For example, an old x-ray which, until that point, was not seen as significant/useful.
- By the end of the tele-consultation, they know whether, or when, the patient will be referred; the decision is made at that point.
- Arrangements for further tests, investigations or procedures to be performed in advance of admission to hospital can be arranged and confirmed.
- Confidence that the patient has received the message about referral.
- The specialist/consultant has 'met' the patient, and has started the initial, important, process of building a relationship.
- The specialist/consultant asks questions ahead of their meeting with the patient. This provides an opportunity for the specialist/consultant to help the patient to manage their expectations and reduce anxiety about the unknown, that is, what is likely to happen.
- As the patient is sitting in a familiar clinic, with a familiar doctor/healthcare professional, it provides an opportunity for the specialist/consultant to alleviate the psychological and physical trauma associated with the subsequent visit.
- It provides an opportunity for the specialist/consultant to help patients to better understand consultation *before* they undertake it, and thus to better prepare for it, as well as to help to 'de-mystify' what is, to many, the unknown processes involved.
- It allows for the doctor/healthcare professional and the specialist/consultant to have confidence that both share (or not !) a common view of their care and treatment.
- Management of the case is negotiated and agreed by all parties, that is, consultant, doctor and patient, thus the potential to make consultation more effective for all participants.
- It may help change the current perceptions that doctors/healthcare professionals and specialists/consultants have of patients and/or healthcare, namely, that patients are relatively passive participants in the process. This brings with it the notion of 'advocacy'. Tele-consultation is a physical (at least) demonstration of the central role that *they* play in

the process, and that patients are (or should be) *active* participants who engage in the management of their own health.

- An opportunity for doctors/healthcare professionals and specialists/consultants to learn from each other more about patients, disease, treatment and related aspects of the management of healthcare.
- An opportunity for doctors/healthcare professionals and specialists/consultants to 'bridge the gap', psychologically speaking, that is seen to exist between primary and secondary/tertiary healthcare.
- Encourages and supports collaborative working between health professionals in different sectors of healthcare.
- The patient can be prepared by the local nurse in advance of the actual consultation (for example, change into a gown) which saves significant time in the actual consultation.

Human and Organisational Factors

As is the case with the adoption of any information system, there are the difficulties associated with using technology in the workplace. Although research demonstrates that patients welcome teleconsultation as a medium for communication and decision-making about their health, experience shows that rolling out platforms such as AIDMAN for use in other surgeries/clinics or other healthcare settings is not just a matter of installing the equipment, although there are technical issues which might limit its uptake on a national scale. One of these limitations is the cost, not only of installation, but also of maintenance and, as anyone who uses computers and related technology knows, a high level of ongoing support is required given the inevitable breakdowns. If there are too many breakdowns, then doctors, nurses and other healthcare professionals will not want to use it, however useful it might be to their clinical work. Another limitation to a system such as AIDMAN is that it necessarily changes the relationships between all involved. Although the teleconsultation brings the doctor/general practitioner (and/or nurses, for example) and the specialist/consultant together, virtually speaking, it has to date been used with healthcare professionals who are positive and enthusiastic, who have (or feel that they have) the necessary interpersonal and other skills to effectively carry out the interaction and who do not mind having their own weaknesses exposed to others, in particular, to the patient. So, for example, a newly-qualified doctor/general practitioner might feel threatened by having to discuss, in front of the patient, an aspect of healthcare with which they are unfamiliar, or admit that they have not carried out certain checks, administered certain treatments already, and so would be reluctant, or even refuse, to use AIDMAN. On the other hand, installing a system such as AIDMAN provides an opportunity for all concerned to learn from each other more about disease, treatment and related aspects of management of care; but some are more resistant to change (which is what learning is all about) than others. Christensen et al (2000) also report several interesting examples of resistance to 'disruptive innovations' in the healthcare sector and, quite rightly, say that this can found at all levels of any organisation, either local or national. There is thus the need for further research into the perceptions of a range of healthcare professionals in a variety of healthcare settings in order to ascertain the types of organisations, and people within them, who will be more (or less) likely to embrace such technology. It is also necessary to find out how, precisely, such technology should be brought onstream in a new setting; it has been installed over several years at Chorleywood in the UK and installing and using it elsewhere will likely need new, and perhaps different, methods and approaches. An information system such as AIDMAN does, of course, cost money. In order for other healthcare professionals to consider its use in their own healthcare settings, there will be a need to provide further explanation as to what particular clinical issues are likely candidates for tele-consultation and which are not. So, for example, although teledermatology has been used with much success, there are some dermatological cases that do not lend themselves to such intervention; the doctor/general practitioner should instead immediately refer the patient to the specialist/consultant.

Experience from many sectors has also shown that introducing technology to the workplace brings its own problems and appropriate management techniques must be adopted early if a project is to be successful. Technology can be notoriously difficult to introduce where existing practice is well established and there can be considerable reluctance to adopt and use unfamiliar technology. Quickly this can turn to a refusal, and the few 'die hard' users can quickly affect discontent amongst others. A few breakdowns or problems will rapidly add fuel to the argument to continue with old practice and it may become difficult to convince users to continue their use of the new system. The

benefits of the new system must be constantly emphasised and demonstrated (why bother to do more work if there is no benefit ?). Christensen et al (2) argue strongly that 'disruptive technologies' are "precisely what are needed to reform healthcare" and that it is in the interests of doctors/general practitioners and/or specialists/consultants to do so (page 109). The authors of this chapter, committed as we are to introducing such technology across the sector, could not agree more. Users should be encouraged and supported and their problems and views must be listened to. Success comes when they start asking for more and new ways of working with the system. Sometimes hard decisions must be taken for the sake of the success of the project. Some people may never accept new practices and the time may come to part ways.

The majority of telemedicine projects span aspects of healthcare as diverse as mental health, diabetes or foetal monitoring. Each system is designed differently, is unlikely to be compatible with another and needs different technical support and user training. Whilst such individual systems have proved useful in a particular context (see, for example, 15, 16, 17, 18, 19, 20), the implications for a national healthcare system mean that each clinic, hospital or other healthcare setting would need to purchase a different technological device for each particular healthcare issue. So, a system for diabetes, another for mental health and yet another for foetal monitoring, and so on. In addition, each device would need different technical support and different user training and would, naturally, take up a great deal of space in the workplace. Maintaining such systems would be problematic and expensive, particularly given the rapidly changing nature of information systems today. It would also be very expensive. In a country such as the UK, where (scarce) financial resources for healthcare come from the taxpayer, it is difficult to see how those managing the healthcare budget would justify the cost in investing in such single, one-issue systems. Another difficulty of such one-issue systems is that a great deal of effort would have to be made in persuading doctors/general practitioners or specialists/consultants to use such systems; only around 12% of these healthcare professionals have computers on their desks and, like many, may not embrace technology with the same enthusiasm as their designers.

The Significance of the Telemedicine Platform

The significance and value of AIDMAN is that it can be applied/used for *every/any* healthcare issue. Indeed, one of the limitations of other systems is that they will not be cost-effective if health service providers have to buy a separate system for different healthcare issues. Doing so would not only be more expensive but it would likely mean a clinic/surgery cluttered with technological devices, each of which would require different training and support. It is difficult to see how, in a healthcare climate where technology is little used that healthcare professionals would be tempted to invest in such a seemingly bewildering array of technological 'kit', – systems must be designed to be general purpose and be re-used for many health areas. Of course this also matches the philosophy of primary care, and it would seem inevitable that system aimed to support this sector will need to be designed to match such requirements. It is also clear that technology can stretch the boundaries for health care and monitoring, and there will be an increasing use of technology to monitor the patient in their own home, or close to home, or even as they go about their daily life, with appropriate data or alarms being sent to the health care professional for advice or intervention. In such a way, changes to a person's state of health might be detected even before they themselves are aware of it, and early intervention can prevent further deterioration which may well result in the need for admission to hospital in order to manage an exacerbation or acute attack of the condition. It is likely primary care will become increasingly responsible for managing chronic illness in the community, and platforms such as AIDMAN offer an excellent means of support to the primary health care team and the patient.

Our experience leads us to conclude that AIDMAN has demonstrated its use and efficacy across a variety of healthcare issues as diverse as dermatology, cardiology and vascular surgery; oncology is soon to join these and offers an interesting tool to support patients through a difficult time and in making difficult decisions. It has proved a versatile platform, and as such should prove cost effective when used in this way. The physical and psychological benefits of AIDMAN to both patient and healthcare professional are such that it allows for richer communication between the patient and the specialist/consultant and between doctor/healthcare professional and the specialist/consultant involved in the health and care of their patient. The roles of both the doctor/healthcare professional and the specialist/consultant differ from the traditional ones, in

particular, the role taken by the doctor/healthcare professional in primary care. Here, they act more in the role of 'advocate' for the patient during the consultation. E-health, as our use of AIDMAN demonstrates, has the potential (in the right hands) to allow patients to engage more fully in their own healthcare and to feel more empowered in the process. Patients want an empathetic approach from healthcare professionals and to feel that what they say is not only 'data' for the healthcare professional to use in the decision-making but that they, as individuals, are valued. They want their voice to be heard, and to feel as much of an equal partner in the relationship and any decision-making. AIDMAN demonstrates that such technology is a powerful tool in helping to bring about a more personalised, empowering interaction for the patient and, importantly, that such interaction has similar benefits to the healthcare professional. So, rather than the technology 'taking over' and making the human interaction *less* personal, as many inside and outside the profession might fear, it instead has the potential to do just the opposite, that is, to enrich and strengthen the human to human communication that is so essential to successful interaction and, in this case, help to ensure that the decision-making is the best that it can be. Our future research agenda includes looking at how, precisely, the consultation process is changed and, importantly, to explore the impact of this on health outcome. Further research and analysis of tele-consultation sessions so far carried out will reveal to what extent these do, or do not, mirror more 'traditional' consultations and whether such a model varies according to clinician, illness or any other factor(s). In order to roll out AIDMAN for use in other surgeries/clinics or other healthcare settings, there is a need to find out the technical, social and other issues which might limit its uptake on a national scale. Another is to explore to what extent AIDMAN can be used by healthcare professionals to learn from each other more about disease, treatment and related aspects of management of care, and how this affects the quality of their decision-making.

Referral to a specialist is an important aspect of healthcare, regardless of how healthcare is organised at local and/or national level. That said, there are important differences related to context. By way of example, Forrest (3) reports that patients in the US are twice as likely as patients in the UK to see a specialist within any twelve-month period although rates of keeping appointments are almost identical. This makes discussion of the role of innovation in successful telemedicine somewhat problematic as what is 'successful' in one context may be regarded differently in another. Telepsychiatry in Canada (21) is regarded by patients as highly successful for a variety of reasons. It would likely be reasonably easy to find plenty of studies in telepsychiatry which could be used to provide evidence that 'telepsychiatry is good', and that given these success stories healthcare organisations around the world should put into place such a service as soon as they can. However, on closer examination of the study, the success, as measured by patients, can be attributed to the fact that the alternative is no psychiatric service at all, or at least not without travelling considerable distance, as the patients live in the remotest regions of Canada. For such patients, *any* service, even if the level of service provided is regarded as poor (by clinicians) when measured against psychiatric services elsewhere, will be rated highly. Geographical location is but one factor that complicates discussion of what is meant by 'success'. Another is who is being asked. Having said that 'success' is problematic in that it does not exist per se but is instead dependent on context and who we ask to gauge any telemedical intervention, innovation is another such issue. Technology plays a vital part in all of our lives these days, and this is as true for the healthcare services as anywhere else. What is important, of course, is that we, as humans, do not allow ourselves to be so seduced by the technology that we lose sight of what it is, that is, a tool. And, like all tools, they are not useful or 'good' in themselves. A spoon is, for instance, a great tool if you want to eat ice-cream but useless if you want to speak to someone in another country. People, in this case patients, do not want innovation, they want to be made better, and as efficiently and effectively as possible. And governments or organisations that pay for healthcare want it done as cheaply as possible. Cost, however, is problematic. It can be measured (with difficulty) in terms of dollars perhaps, with low cost being seen as synonymous with 'success'. Indeed, Whitten et al (22) make it clear from their study of 612 articles which attempted to measure actual cost benefit data of telemedicine services that there is absolutely no good evidence that such benefits exist. We might conclude from this that telemedicine on a wider scale, nationally and internationally, might thus be doomed. However, one of the difficulties with this evidence is that it is naturally gathered only from small-scale projects, in one location, for one particular healthcare issue. Given this, it is unsurprising that these have not proved cost-effective; they are measured as stand-alones, and contrasted with normal practice for a particular cohort of patients undergoing a particular type of treatment or path. It may also be the case that the telemedicine is being used to deliver the same healthcare, only by a slightly different method, and that within the global economy, there will be little

benefit as only one small component is being affected. Indeed, the most often reported outcome of a telemedicine pilot is a reduction in the number of referrals on to the next higher level of healthcare, and post analysis normally shows that this has come about because of the *educational* aspects that the telemedicine system delivers. Furthermore, as the pilot progresses, there is often an accompanying reduction in the use of the telemedicine system as the remote healthcare professional becomes confident to make the decisions themselves and unsupported. The conclusion is that AIDMAN offers much more than a simple referral tool, and we need to examine the further potentials. Instead, we need to envision something far more radical; the AIDMAN system (if it can be called that) as *the* system, on a national scale. Unfortunately, a randomised clinical trial, so often seen as the only reasonable and/or reliable method of testing a new service or drug in journals the healthcare sector is clearly not going to be possible. What is proving, to us at least, far more difficult to model is the cost (economically and otherwise) of having such a system operating across the whole healthcare sector in the UK. We are working on it, however ! Presented in this chapter is the technological innovation layer of the six-layer onion described earlier, although as this conclusion demonstrates, this cannot be divorced from the other layers which together make their contribution to organisational learning and success. As for whether there is enthusiasm for such 'disruptive innovation' at all levels of the healthcare system in the UK, the answer is, as ever, dependent on who is being asked. There are fervent supporters of such innovation at all levels, but innovation always has its critics. That said, it is our view that the UK is ready to embrace a system that Christensen et al (2) would call a 'disruptive innovation'.

It would seem to us that implementing a local, national or even global information system, in this case a healthcare one such as AIDMAN, is not about healthcare per se but instead about the ability to successfully manage change. As Christensen et al (2) rightly note, improving healthcare by introducing 'disruptive innovations' involves a complex mix of people, from governments through to an individual in a particular healthcare setting. Whilst exhorting the leaders at national and local levels to work more closely together, Christensen et al (2) rightly recognise that effective leadership is key. However, as Fitzgerald et al (23) note, effectively managing change cannot be reduced to a set of 'critical success factors'; human behaviour (and that is what we are talking about with information systems) is far more complex than that. However, successful information systems might be characterised as having the following:

1. Driven by the business need rather than the technology.
2. Clear backing and commitment from many within the organisation.
3. Any project, big or small, must have its champions, and at different organisational levels. Such 'movers and shakers' must be prepared to carry their vision through and to be accountable for its implementation.
4. Teamwork within the organisation more generally.
5. Teamwork at the level of the development itself.
6. Humour and common sense (this is in extremely short supply in any organisation, unfortunately !).
7. Involve the users of the ICT when designing it.
8. Project management is clearly a vital factor in ensuring a project's success. However, 'project management' is as much about 'people management' as managing the actual product, the system, itself.
9. Central to the success of any new system, whether an ICT one or otherwise, is the management of people's expectations.

In the end, all systems development, or indeed any change, is about the management of risk. Do those 'movers and shakers' exist in the National Health Service and the government in the UK ? Do they have a vision and the skills and abilities to make it work in practice ? The cynics amongst us would perhaps doubt that such organisations, loathe to change as they are, have such people. As patients, we can only hope that they do !

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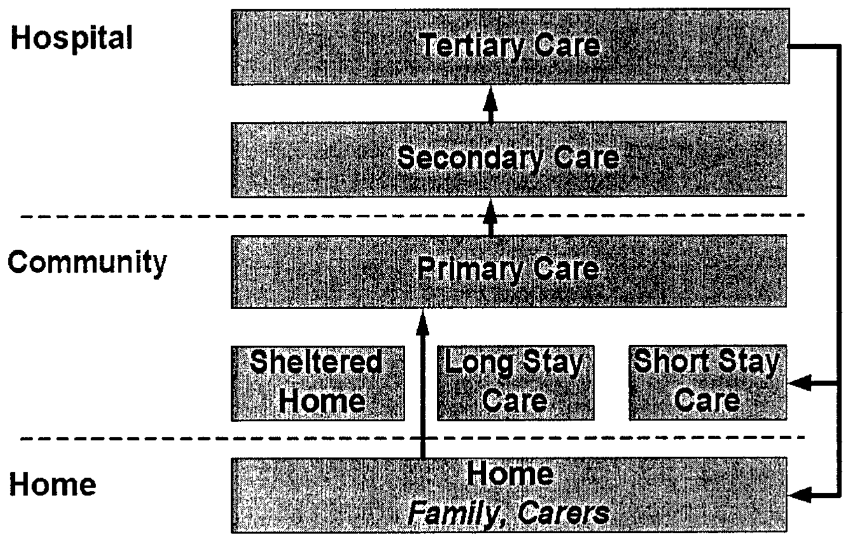

Figure 1: Health care structure

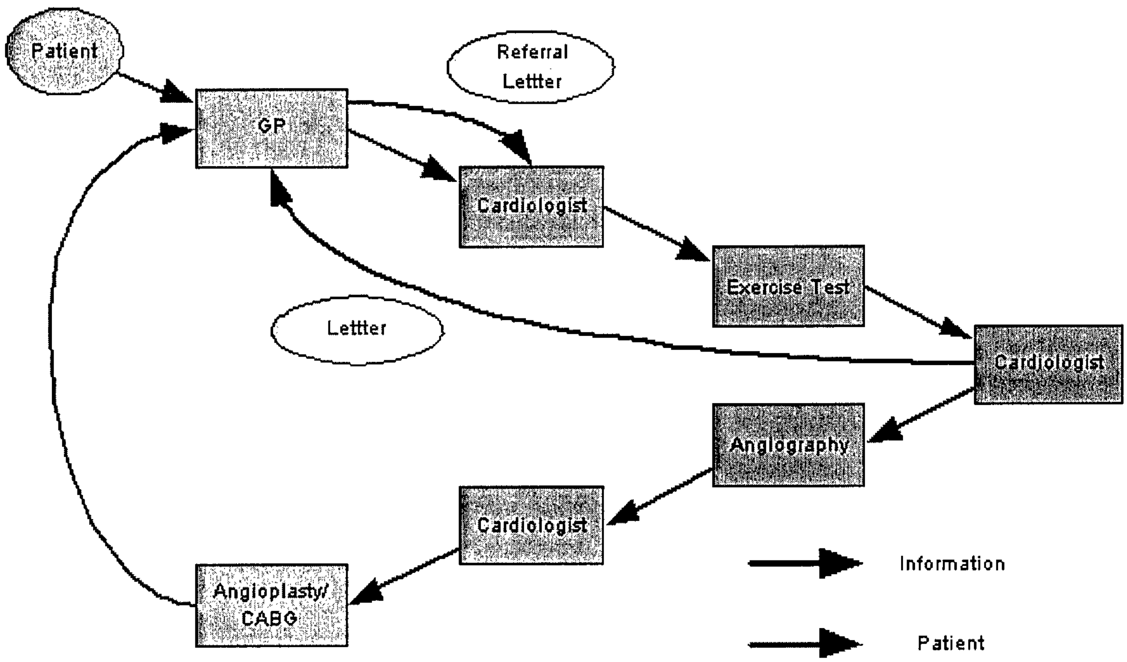

Figure 2: Pathway of Care for Coronary artery Disease

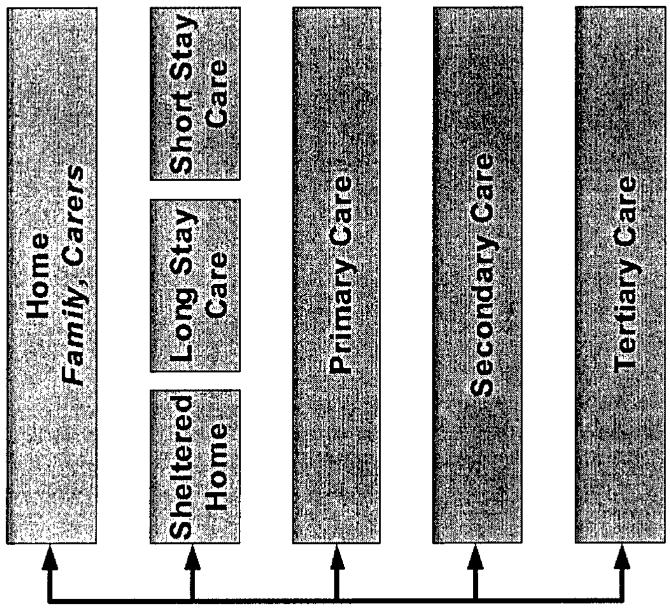

Figure 3: Health Care Structure of the AIDMAN Platform

Figure 4: Patient (left) and local nurse (right) during a dermatology teleclinic. There is a digital camera which gives real time analogue video and can capture very high resolution digital image of same scene. A second camera on top of monitor is used for "talking heads".

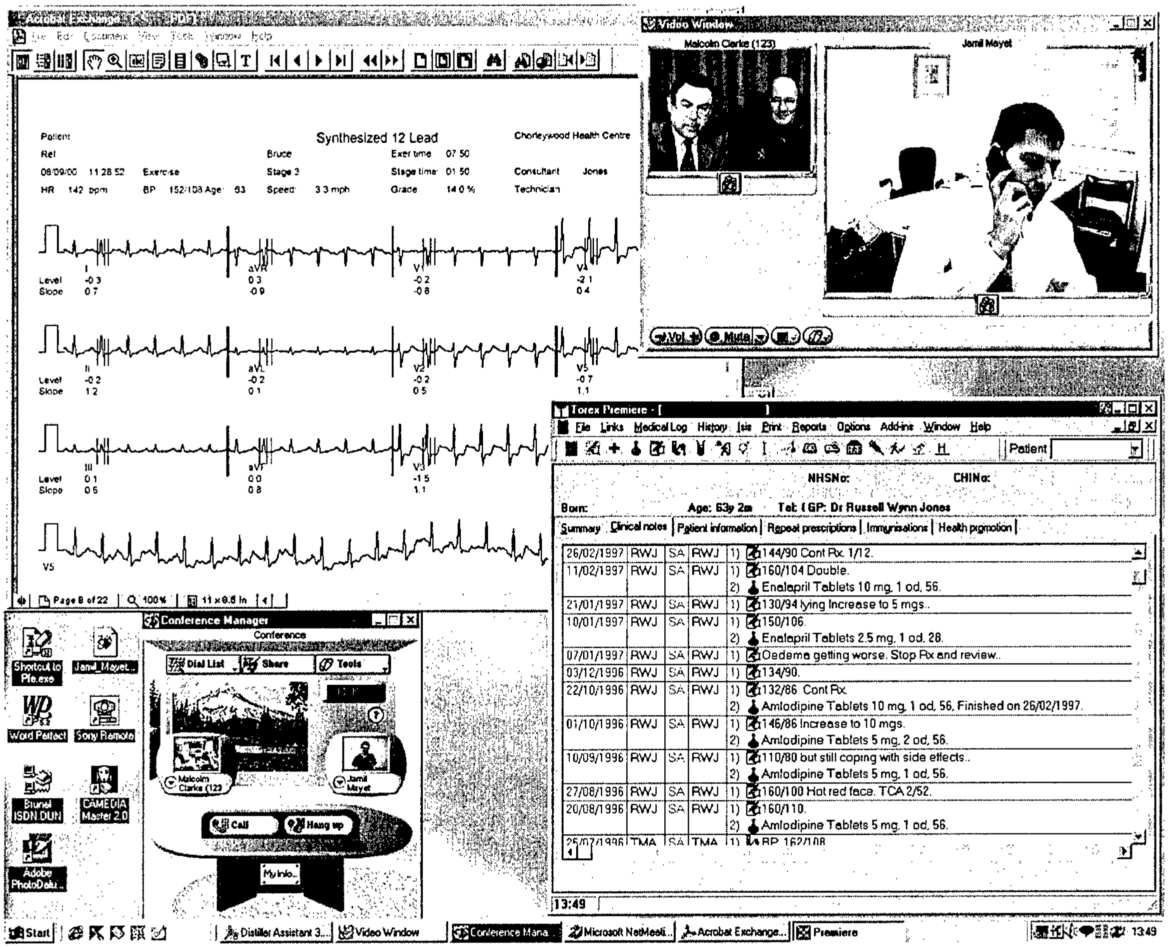

Figure 5. Screenshot of a typical cardiology tele-clinic showing the combination of video-conference, test results, data and application sharing.

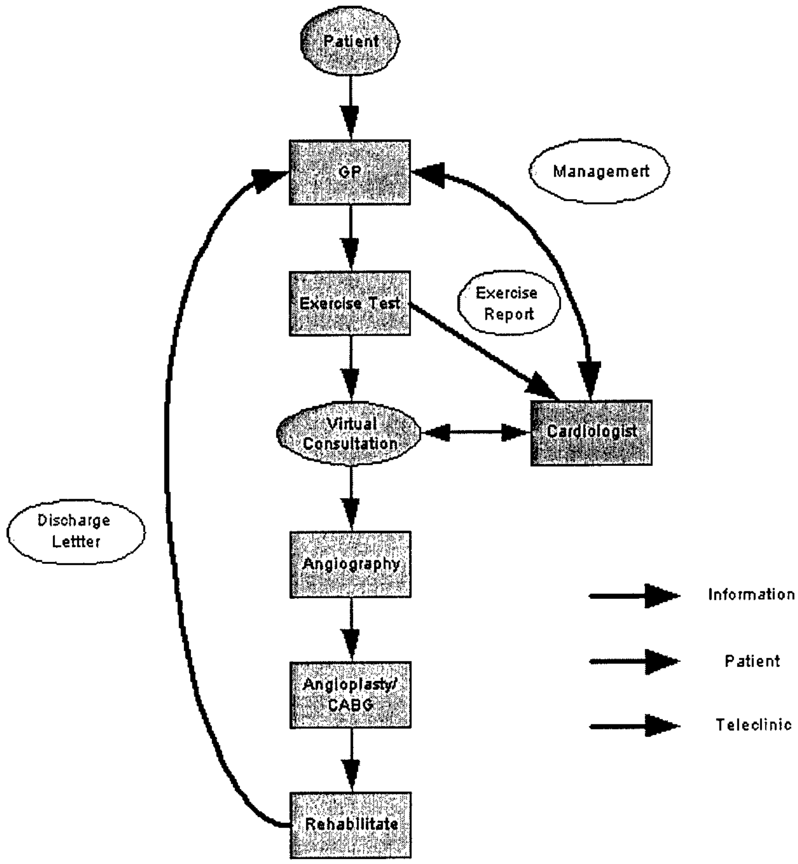

Figure 6: Technology supported Pathway of Care

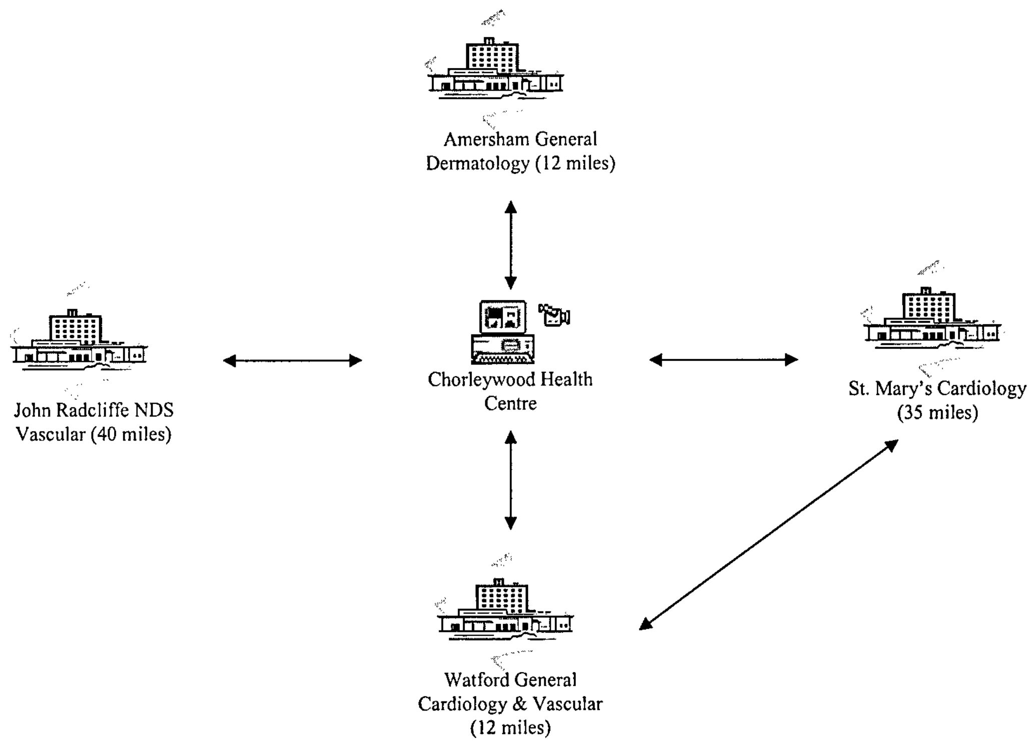

Figure 7: An Illustration of the current AIDMAN Project between the Primary Care and the Secondary Care Levels.

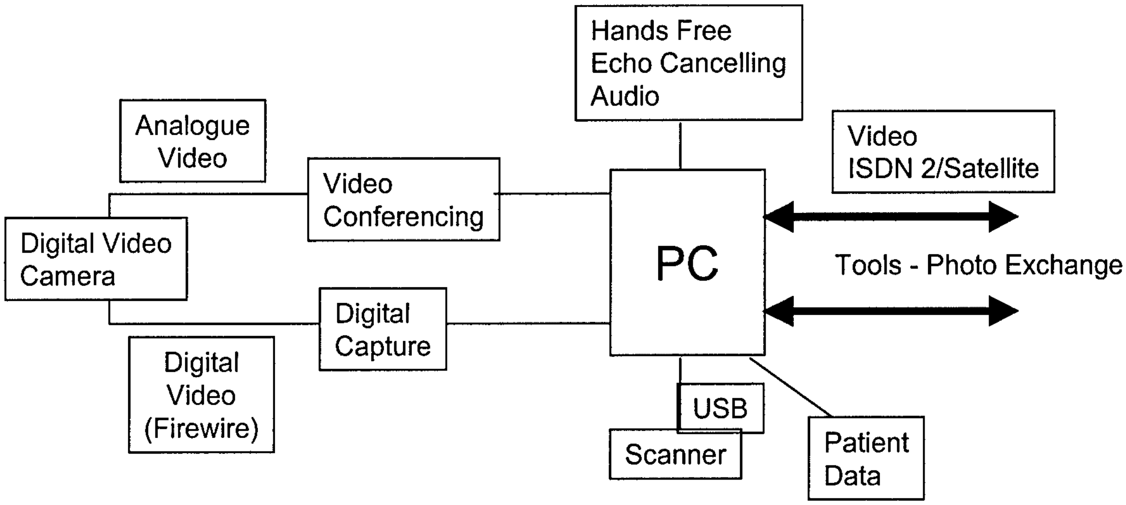

Figure 8: The Architecture of a teleclinic in an end-station

Health care may be the most entrenched, change-averse industry in the United States. The innovations that will eventually turn it around are ready, in some cases – but they can't find backers.

Will Disruptive Innovations Cure Health Care?

by Clayton M. Christensen, Richard Bohmer, and John Kenagy

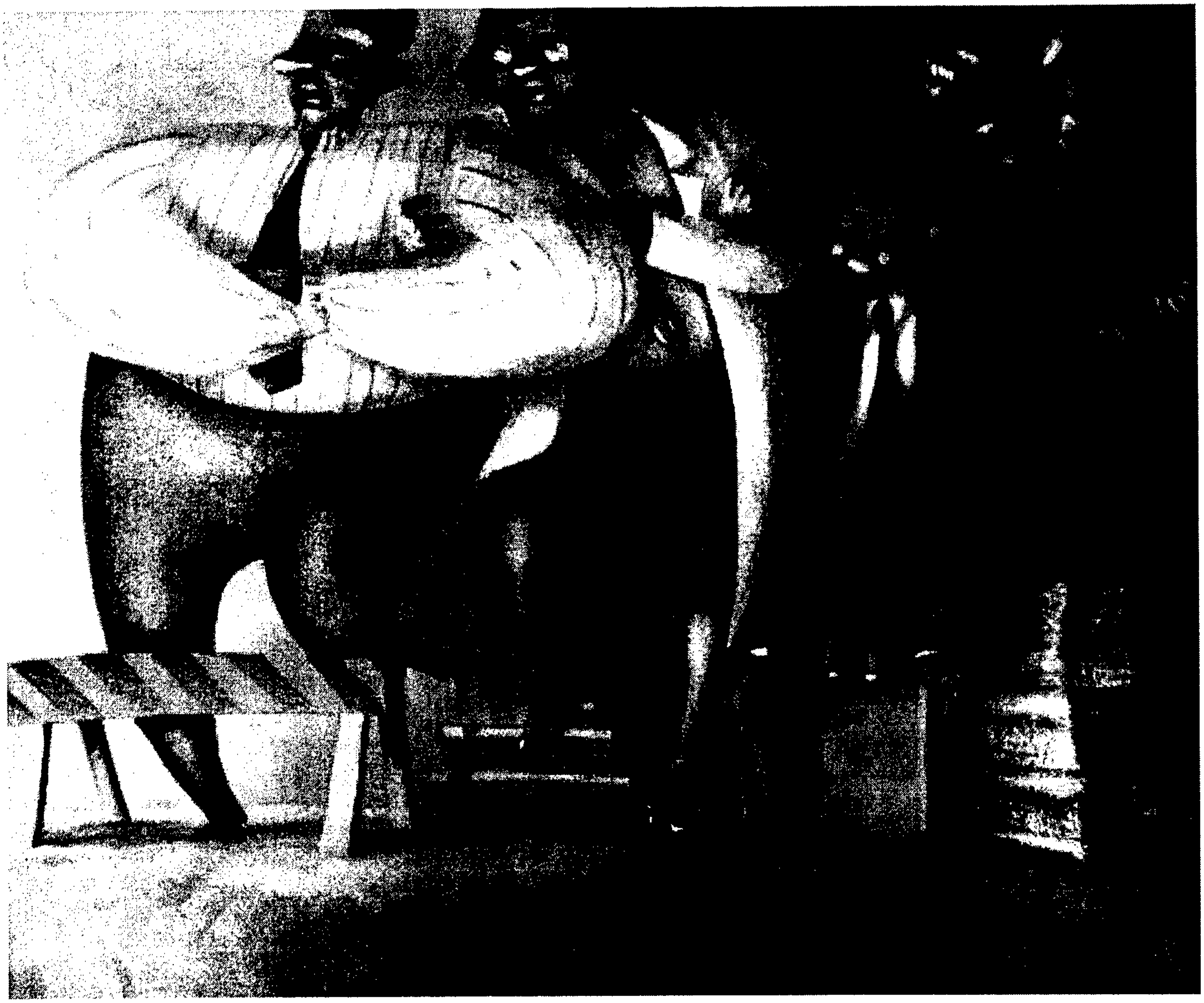

ILLUSTRATION BY BARBARA HRANILOVICH

IMAGINE A PORTABLE, LOW-INTENSITY X-ray machine that can be wheeled between offices on a small cart. It creates images of such clarity that pediatricians, internists, and nurses can detect cracks in bones or lumps in tissue in their offices, not in a hospital. It works through a patented "nanocrystal" process, which uses night-vision technology borrowed from the military. At 10% of the cost of a conventional X-ray machine, it could save patients, their employers, and insurance companies hundreds of thousands of dollars every year. Great innovation, right? Guess again. When the entrepreneur who developed the machine tried to license the technology to established health care companies, he couldn't even get his foot in the door. Large-scale X-ray equipment suppliers wanted no part of it. Why? Because it threatened their business models.

What happened to the X-ray entrepreneur is all too common in the health care industry. Powerful institutional forces fight simpler alternatives to expensive care because those alternatives threaten their livelihoods. And those opponents to low-cost change are usually lined up three or four deep. Imagine for a moment that our entrepreneur was able to license the technology. Even then, he would probably face insuperable barriers. Regulators, afraid of putting patients at risk, would withhold approvals. Radiologists, who establish the licensing standards that regulators enforce, don't want to lose their jobs, so they'd fight it, too. Insurance companies, which approve only established licensed procedures, would refuse to reimburse for it. And hospitals, with their large investments in radiology and emergency departments, want injuries to flow to them – so they, too, would join the forces holding back change.

This resistance to low-cost alternatives is understandable, but it's not in the best interests of the industry or of the patients it serves. Quite the reverse – the health

care industry desperately needs to open its doors to market forces. Health care professionals often shudder when they hear that phrase "market forces." But when we use it, we're not talking about letting insurance companies micromanage doctors as they practice medicine or about putting profits above patient care. Rather, we're talking about being open to disruptive technologies and business models that may threaten the status quo but will ultimately raise the quality of health care for everyone.

Make no mistake: the U.S. health care industry is in crisis. Prestigious teaching hospitals lose millions of dollars every year. Health care delivery is convoluted, expensive, and often deeply dissatisfying to consumers. Managed care, which evolved to address some of these problems, seems increasingly to contribute to them – and some of the best managed-care agencies are on the brink of insolvency. We believe that a whole host of disruptive innovations, small and large, could end the crisis – but only if the entrenched powers get out of the way and let market forces play out. If the natural process of disruption is allowed to proceed, we'll be able to build a new system that's characterized by lower costs, higher quality, and greater convenience than could ever be achieved under the old system.

What's Wrong with Health Care

In any industry, a disruptive innovation sneaks in from below. While the dominant players are focused on improving their products or services to the point where the average consumer doesn't even know what she's using (think overengineered computers), they miss simpler, more convenient, and less costly offerings initially designed to appeal to the low end of the market. Over time, the simpler offerings get better – so much better that they meet the needs of the vast majority of users. We've seen this happen recently in the telecommunications industry, where routers – initially dismissed by leading makers of the faster, more reliable circuit switches – came to take over the market.

The graph "The Progress of Disruptive Innovation" illustrates this dynamic. The top solid line depicts the pace of technological innovation – the improvement an industry creates as it introduces new and more-advanced products to serve the more-sophisticated customers at the high end of the market. We call these *sustaining innovations*. The shaded area outlines the rate of improvement consumers can absorb over the same time. The pace of sustaining innovation nearly always outstrips the ability of customers to absorb it. That creates the potential for upstart companies to introduce *disruptive innovations* – cheaper, simpler, more convenient products or services that start by meeting the needs of less-demanding customers. The progress of these disruptive innovations is shown by the bottom solid line. Disruptive technologies have caused many of history's best companies to plunge into crisis and ultimately fail.[1]

This phenomenon of overshooting the needs of average customers and creating the potential for disruption quite accurately describes the health care industry. If we were to draw a graph to illustrate health care specifically, we would measure the complexity of diagnosing and treating various disorders on the vertical axis. The least-demanding tiers of the market are patients with disorders such as simple infectious diseases. The most-demanding tiers include patients with complex, interactive problems such as an elderly man with a broken hip complicated by poor health from long-standing diabetes, hypertension, and heart disease – situations in which multiple systems of the body are involved, and cause and effect are difficult to disentangle.

Our major health care institutions – medical schools, groups of specialist physicians, general hospitals, research organizations – have together overshot the level of care actually needed or used by the vast majority of patients. Indeed, most players in today's health care system are in a lockstep march toward the most scientifically demanding challenges. Between 1960 and now, for example, our medical schools and residency programs have churned out specialists and subspecialists with extraordinary capabilities. But most of the things that afflict us are relatively straightforward disorders whose diagnoses and treatments tap but a small fraction of what our medical schools have prepared physicians to do. Similarly, the vast majority of research funding from the National Institutes of Health is aimed at learning to cure diseases that historically have been incurable. Much less is being spent on learning how to provide the health care that most of us need most of the time in a way that is simpler, more convenient, and less costly.

General hospitals – especially teaching hospitals – have likewise overshot the needs of most patients. Their impressive technological ability to deliver care enables them to address the needs of a relatively small population of very sick patients. But in the process of adding and incurring the costs of such capabilities, they have come to overserve the needs of the much larger population of patients with less serious disorders. Most types of patients that occupied hospital beds 20 years ago are not there today; they're being treated in lower cost, more-focused settings. As the stand-alone cardiac care centers, outpatient surgery centers, and other focused institutions get better and better, they become the price

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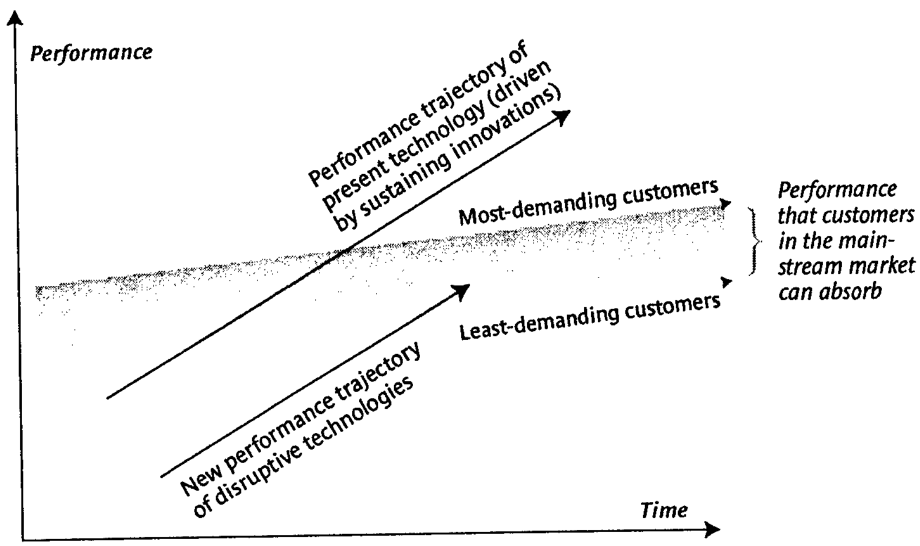
The Progress of Disruptive Innovation

Dominant players in most markets focus on sustaining innovations – on improving their products and services to meet the needs of the profitable high-end customers. Soon, those improvements overshoot the needs of the vast majority of customers. That makes a market ripe for upstart companies seeking to introduce disruptive innovations – cheaper, simpler, more convenient products or services aimed at the lower end of the market. Over time, those products improve to meet the needs of most of the market, a phenomenon that has caused many of history's best companies to plunge into crisis.



setters. As a consequence, the old high-cost institutions can't compete financially; nor are there enough really sick people to sustain them. Last year not a single teaching hospital in Massachusetts made money.

As a group, the medical schools, specialist physicians, hospitals, and equipment suppliers have done an exceptional job of learning to treat and resolve difficult, intractable problems at the high end. We stand in awe of what they have accomplished. But precisely because of their achievements, health care is now ripe for disruption.

How Disruptive Innovations Work

To get a sense of what those disruptions might be, let's look briefly at what has happened in other industries. Many of the most powerful innovations that disrupted other industries did so by enabling a larger population of less-skilled people to do in a more convenient, less expensive setting things that historically could be performed only by expensive specialists in centralized, inconvenient locations.

For example, in the 1960s when people needed computing help, they had to take their punched cards to the corporate mainframe computer center and wait in line for the data-processing specialists to run the job for them. Minicomputers and then personal computers were disruptive technologies to the mainframe makers. At the outset, they weren't nearly as capable as mainframes, and as a consequence the professionals who operated the sophisticated computers, and the companies that supplied them, discounted their value. But minicomputers enabled engineers to solve problems for themselves that had required centralized computing facilities. And personal computers enabled the unwashed masses – less-skilled people like the rest of us – to compute in the convenience of their offices and homes.

Nearly every disruptive innovation in history has had the same impact. George Eastman's camera made amateur photography widespread. Bell's telephone let people communicate without the need for professional telegraph operators. Photocopying enabled office workers to do things that historically only professional printers could do. On-line brokerages have made investing so inexpensive and convenient that even college students now actively manage their own portfolios. Indeed, disruptive technologies have been one of the fundamental mechanisms through which the quality of our lives has improved. In each of these cases, the disruption left consumers far better off than they had been – we don't yearn to return to the days of the corporate mainframe center, for example.

Our health care system needs to be transformed in the same way. Rather than ask complex, high-cost institutions and expensive, specialized professionals to move down-market, we need to look at the problem in a very different way. Managers and technologies need to focus

instead on enabling less expensive professionals to do progressively more sophisticated things in less expensive settings.

We need diagnostic and therapeutic advances that allow nurse practitioners to treat diseases that used to require a physician's care, for example, or primary care physicians to treat conditions that used to require specialists. Similarly, we need innovations that enable procedures to be done in less expensive, more convenient settings – for doctors to provide services in their offices that used to be done during a hospital stay, for example. The graphs "Disruptions of Health Care Professions" and "Disruptions of Health Care Institutions" suggest the patterns by which these disruptive innovations might transform health care.

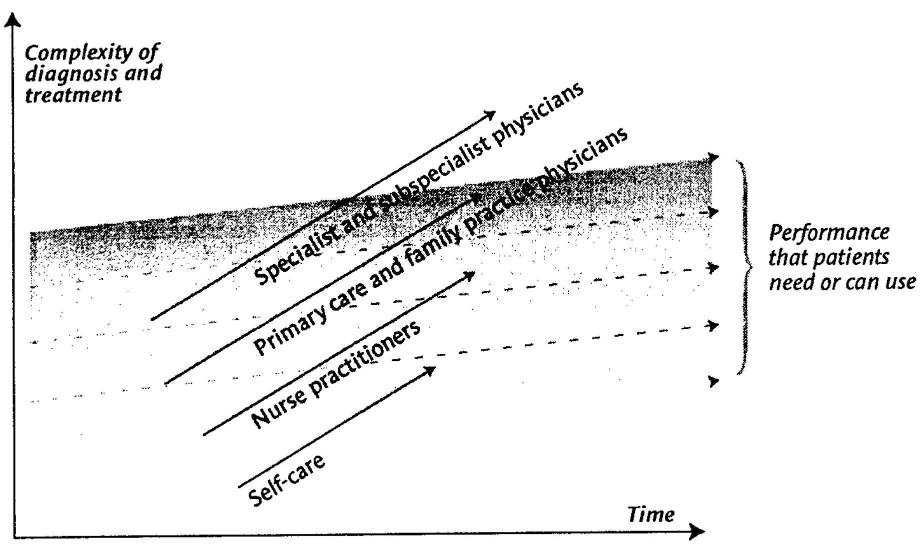
Some innovations of exactly this sort have transformed pockets of the health care system, and where they have happened, higher quality, greater convenience, and lower cost actually have been achieved. Before 1980, for example, patients with diabetes could only know whether they had abnormal levels of glucose in their blood indirectly; they used an often inaccurate urine test or visited a doctor who drew a blood sample and then measured its glucose content on an expensive piece of laboratory equipment. Today, patients pack miniature blood glucose meters with them wherever they go; they themselves now manage most aspects of a disease that previously had required much more professional involvement. They get far higher quality care far more conveniently. No patient or professional pines for the good old days – even though the companies that made the large laboratory blood-glucose testers were all driven from the market, and endocrinologists now face significantly reduced demand for their services.

Angioplasty is another example. Before the early 1980s, patients with coronary artery disease were treated through bypass surgery. It required a complex, technologically sophisticated surgical team, as well as multiple specialists in several disciplines, complicated equipment, days in the hospital, and weeks in recovery. The far simpler angioplasty uses a balloon to dilate narrowed arteries, causing less pain and disability. It enables less expensive or specialized practitioners to treat more people with coronary artery disease in lower cost settings. Initially, angioplasty was used in only the easiest cases and was much less effective than surgery. Experts viewed the procedure with skepticism because of all the things it and its practitioners couldn't do. But over time the disruptive innovation improved. Increasing skill and experience, together with sustaining technological innovations such as stents, have allowed angioplasty to supplant surgery in many cases. Angioplasty can now be reliably performed in stand-alone cardiac care centers, which aren't burdened with the tremendous overhead costs of hospitals.

By enabling less expensive practitioners to treat diabetes and coronary artery disease in less costly locations, these disruptive innovations have made health care

Disruptions of Health Care Professions

As specialist physicians continue to concentrate on curing the most incurable of illnesses for the sickest of patients, less-skilled practitioners could take on more complex roles than they are currently being allowed to do. Already, a host of over-the-counter drugs allow patients to administer care that used to require a doctor's prescription. Nurse practitioners are capable of treating many ailments that used to require a physician's care. And new procedures like angioplasty are allowing cardiologists to treat patients that in the past would have needed the services of open-heart surgeons.



more efficient. But more important, no compromises in quality were made. On the contrary, more patients get more care. When care is complex, expensive, and inconvenient, many afflictions simply go untreated. Before the disruption of angioplasty, for example, many people with coronary artery disease were not treated. Patients had to be disabled with chest pain or at risk of heart attack to justify the expense and inconvenience of open-heart surgery.

We need many more such disruptions – and today we have them within our reach. Unfortunately, the people and institutions whose livelihoods they threaten often resist them. We saw such resistance in the story of the portable X-ray machine. Here's another example. An English entrepreneur has developed a system for customizing eyeglasses quickly and efficiently. The patient puts on a pair of eyeglasses with seemingly flat lenses and an odd-looking rubber bulb attached to each stem. Looking at a vision-test chart and covering one eye, she squeezes the bulb on the right stem until she can read the fine print on the chart. A monomer in the bulb shapes the lens until that eye can see perfectly. She repeats the process for the other eye. Within two minutes, she has perfectly tailored eyeglasses – at a cost of about $5. This is a disruptive technology. It lets patients do for themselves something that historically required the skill of professionals.

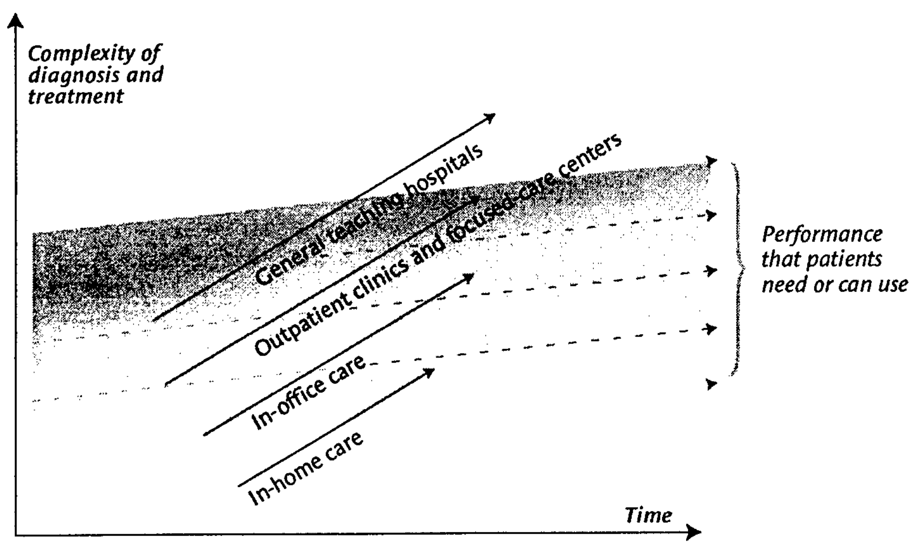
Predictably, the established professions quickly mobilized to discredit the entrepreneur's technology, asserting that dangers such as glaucoma might go undetected if patients corrected their own vision and that for the long-term well-being of patients, care of the eyes must be left in the hands of professionals. Of course this is a reasonable concern. But it frames the problem incorrectly. The problem should be, instead, let's find a way to allow patients to correct vision for themselves while finding new ways for professionals to catch potentially serious disorders at an early stage.

Such resistance affects not only technology but people as well. Take nurse practitioners and physicians' assistants. Because of advances in diagnostic and therapeutic technologies, these clinicians can now competently, reliably diagnose and treat simple disorders that would have required the training and judgment of a physician only a few years ago. Accurate new tests, for example, allow physicians' assistants to diagnose diseases as simple as strep infections and as serious as diabetes. In addition, studies have shown that nurse practitioners typically devote more time to patients during consultations than

When care is complex, expensive, and inconvenient, many afflictions simply go untreated.

Disruptions of Health Care Institutions

Teaching hospitals incur great costs to develop the ability to treat difficult, intractable illnesses at the high end. In the process, they have come to overserve the needs of the much larger population of patients whose disorders are becoming more and more routine. Most types of patients that occupied hospital beds 20 years ago are now being treated in more-focused care centers and outpatient clinics, doctors' offices, and even at home.



By now it's clear that the simplest ailments can be reliably treated and diagnosed by less highly skilled clinicians – and also that institutional forces will fight that reality.

physicians do and emphasize prevention and health maintenance to a greater degree.[2] But many states have regulations that prevent nurse practitioners from diagnosing diseases or from prescribing treatment that they are fully capable of handling.

The flawed rationale behind such policies is that because nurse practitioners are not as highly trained as physicians, they are not capable of providing care of comparable quality. This is the same logic that minicomputer makers used to discredit the personal computer. When a physician diagnoses a simple infectious disease, the patient uses only that fraction of the physician's training that relates to simple infectious diseases. Studies have shown that nurse practitioners with comparable training in simple infectious diseases can provide care of comparable quality in that tier of the market – even though they lack training in more complex disorders.[3]

Some nearsighted advocates of patients' rights assert that nurse practitioners might not have the judgment to recognize when a disorder is beyond their expertise. But family practice doctors recognize when they can treat a disorder and when it merits referral to a specialist. Surely nurse practitioners, working at even simpler tiers of the market, can be equipped to do the same thing. The real reason for blocking such disruption, we suspect, is the predictable desire of physicians to preserve their traditional market hegemony.

Instead of working to enable the natural upmarket migration that is an intrinsic part of economic progress, today's managed care organizations, insurers, and regulators have done just the opposite. They have forced highly trained physicians down-market to diagnose ear infections and bronchitis and have prevented nurse practitioners from doing things that technology enables them to do perfectly well. The result of this policy is perverse. To maintain their incomes, primary care physicians are forced to churn patients at an alarming rate – frequently spending only a few minutes with each patient. That reduces the quality and convenience of care.

This practice, which has become pervasive in most managed care organizations, is akin to what would have happened if some regulatory body in the early 1980s had decreed that because microprocessors were inferior in computing power to wired logic circuits, all personal computers had to be equipped with wired logic boards, not microprocessors. Such a regulation would have halted the industry's progress. The fact that we were able to use microprocessor-based computers for the jobs they were capable of handling, and wired-logic-based machines for the jobs for which microprocessors weren't suited, has been a key to the creation of high-quality, convenient, cost-effective computing for all of us. Enabling less expensive people to do things that were previously unimaginable has been one of the fundamental engines of economic progress – and the established health care institutions have fought that engine tooth and nail.

Solutions to the Crisis

The crisis in health care is deep, to be sure. But the history of other disruptive revolutions offers a number of suggestions for how a systemic transformation might be managed. We describe some of these here:

Create – then embrace – a system where the clinician's skill level is matched to the difficulty of the medical problem. Medical problems range from the very simple to the very complex, as we've said. Let's look more closely at that range for a moment. In the simplest tiers, diagnosis and treatment can be rule-based: accurate data yield an unambiguous diagnosis, indicating a proven therapeutic strategy. Many infectious diseases fall

into this category. In the middle tiers, diagnosis and treatment occur through pattern recognition – no single piece of data yields an answer, but multiple data points lead to a definitive diagnosis. The onset of Type I diabetes, for example, is diagnosed when a pattern is observed – blurry vision, incessant thirst, weight loss, and frequent urination. Once a diagnosis is confirmed, relatively standardized treatment protocols often exist. In the most complex disorders, diagnosis and treatment occur in a problem-solving mode. These problems require the collective experience and judgment of a team of clinical investigators and often involve cycles of testing, hypotheses, and experimentation.

By now it's clear that the simplest tiers can be reliably treated and diagnosed by less highly skilled clinicians – and also that institutional forces will fight that reality. We cannot allow such opposition to arrest reform. Instead, we must invent processes that can channel complex problems, which can't be solved in a rule-based mode, to clinicians whose skills are appropriate to a pattern-recognition or a problem-solving mode.

Scientific progress moves disorders that used to be dealt with in a problem-solving mode toward a pattern-recognition mode and those that had to be addressed through pattern recognition toward a rule-based regime. Mapping the human genome will accelerate this process. Not long ago, for example, leukemia was thought to be a single disease. Diagnosing and treating it was complex – no two patients responded identically to the same therapy, and treatment required the experience, intuition, and problem-solving skills of the best oncologists. Our improved understanding of the human genetic code, however, has helped researchers see that what we previously called leukemia is really at least six different diseases. Each is characterized by a specific genetic pattern, and patients can be precisely diagnosed by matching their patterns to a template.

Where once therapy used to be applied experimentally, such precise definition of the disease will allow for precise treatment protocols. Disruptive technologies such as this are precisely what are needed to reform health care. They will continue to enable less-experienced caregivers to make more precise diagnoses and provide higher quality care than they could have in problem-solving mode.

It's in physicians' interest to embrace this change. Rather than fight the nurse practitioners who are invading their turf, primary care physicians should move upmarket themselves, using advances in diagnostic and therapeutic technologies to perform many of the services they now refer to costly hospitals and specialists. They should, in other words, disrupt those above them rather than fight a reactionary and ultimately futile battle with disrupters from below.[4] Let us be clear. Many managed care organizations today give primary care

Patient Welfare in Disruptive Times

How might patients fare amidst health care disruptions? The answer depends on whether competitive markets are allowed to work efficiently. If clinicians or patients are forced to use less expensive technologies, disaster will result. But if consumers and providers are given choices, the use of disruptive technologies will migrate to those applications where they create real value.

Consider Sonosite, a Seattle-area company that makes a small, highly portable, inexpensive ultrasound machine. The machine is good, but it is disruptive – it lacks the analytical features and the degree of resolution found in more expensive ultrasound equipment. If a managed care organization forced echocardiologists and OB-GYN physicians to use these less expensive devices for situations in which they previously have used traditional equipment, a specialist could risk missing something important, and the patient's well-being could be compromised. But suppose instead that because Sonosite's technology now makes ultrasound accessible and affordable to generalist clinicians, they could begin to provide better, more accurate care within the low-cost and more convenient context of their offices. Instead of conducting exams in which they hypothesize about what's going on inside a patient's body by listening through a stethoscope or by using their fingers to probe for irregularities, they could use this simple ultrasound device that would let them see inside the body. By enabling generalists to diagnose more quickly and with greater precision, disruptive technologies such as Sonosite's can improve, not compromise, the cost, quality, and convenience of care.

Ultimately, we would expect that the disruptive portable machines will improve to the point that they will supplant the more expensive traditional ultrasound equipment in established applications as well. But the true transformative impact of such technologies in health care will come as they allow less expensive professionals to provide better care.

If history is any guide, the established high-end providers of products and services are likely to be articulate and assertive about preserving existing systems in order to ensure patient well-being. Very often, however, their eloquence reflects concerns about their own well-being. Customers have almost always emerged from disruptive transitions better off – as long as the disruptions are not forced into an old mode, but instead enable better service to be delivered in a less-costly, more convenient context.

physicians a financial incentive *not* to refer patients to specialists – to continue treating patients they are not competent to care for. Inviting them to move incompetently upmarket is a recipe for disaster. Disruptive technologies such as those we have described will enable these caregivers to move *competently* upward. These innovations are the sort that will reform health care. This strategy – unlike the one that pushes these physicians down-market or encourages them upward without enabling technology – is consistent with the way technological progress and customer needs interact.

Invest less money in high-end, complex technologies and more in technologies that simplify complex problems. Equity markets have not been generous to companies making health care products and equipment in recent years. Other sectors of the economy are perceived to exhibit greater growth and profit potential. One reason for this, we believe, is that much of the energy and capital spent in the development of new health care products and services have been targeted at the high end – at sustaining technologies that enable the most skilled practitioners to solve problems that could not be solved before. We do not contest the value of these innovations – but they will not transform health care. The great growth opportunities exist in the simpler tiers of the market. History tells us that major new growth markets coalesce when products, processes, and information technologies let less highly paid groups of people do things in more convenient settings. To truly disrupt the health care system, venture capital, entrepreneurial energy, and technology development need to flow toward these enabling initiatives. Rather than focus on complex solutions for complex problems, research and development need to focus on simplification.

It's not entirely clear why more venture capital hasn't flowed in this direction. One possible reason is that individual entrepreneurial companies don't get to pick fights with individual Goliaths – more often, they face an army of giants. Because regulators, litigators, insurers, physicians, hospitals, and medical schools have such powerful interlocking interests in the status quo, disruption might require the concerted strategic focus of major health care companies such as Johnson & Johnson, Baxter, Medtronic, or Merck. Over time, they could overcome the inertia of entrenched institutions. A series of disruptive business ventures launched by these companies would create far greater growth for them, with less investment, than would continued pursuit of sustaining technologies that enable specialists to push further into high-end complexities.

Create new organizations to do the disrupting. The health care industry today is trying to preserve outmoded institutions. Yet the history of disruptive innovations tells us that those institutions will be replaced, soon enough, with new institutions whose business models are appropriate to the new technologies and markets.

When disruptive innovations have invaded the mainstream markets of other industries, a difficult period typically has preceded the arrival of truly convenient, lower cost, higher quality products and services. Between 1988 and 1993, for example, as networked personal computers became the dominant information technology architecture, the former industry leaders fell into disarray. Together, the mainframe and minicomputer makers logged $20 billion in operating losses during that period. None of these companies was able to adapt its business model to compete in the personal computer world. Instead, they seemed able only to tighten the thumbscrews on their existing processes, attacking costs through mergers and layoffs, as they withered away. During this period, it wasn't the computer industry that was in crisis – only its traditional institutions were. Disruptive innovators such as Intel, Sun, Microsoft, and Dell were creating extraordinary value.

Instead of working to preserve the existing system, health care regulators need to ask how they can enable disruptive innovations to emerge.

The massive financial losses that hospitals and managed care institutions are suffering today mirror exactly what happened to the dominant players in other disrupted industries. And they are responding in the same way – by tightening controls on their existing business models. They are merging, closing facilities, laying off workers, forming buying groups, delaying payments, adding layers of control-oriented overhead workers, and hiring consultants – while going about their work in a fundamentally unchanged way. In fact, the billions of dollars large general hospitals are spending to build information technology systems and to create integrated feeder systems of physicians' group practices and primary-, secondary-, and tertiary-care hospitals are designed to preserve, rather than displace, the existing institutions.

We will always need some general hospitals to provide intensive and critical care to the sickest patients, just as we still need IBM and Hitachi to make mainframe computers for the most complex computing applications. But it is very likely that the care of disorders that primarily involve one system in the body – from earaches to cardiac and renal illnesses – will migrate to focused institutions whose scope enables them to provide better care with less complexity-driven overhead. If history is any

guide, the health care system can be transformed only by creating new institutions that can capably deliver the vast majority of such care, rather than attempting a tortuous transformation of existing institutions that were designed for other purposes.

Leaders of today's hospital and managed care companies might profit from comparing the approaches that S.S. Kresge and F.W. Woolworth took toward disruptive discount retailing, beginning in the early 1960s, as recounted in Clayton Christensen's *The Innovator's Dilemma*. Kresge addressed the disruption by systematically closing 10% of its variety stores every year and funneling all its cash into its disruptive start-up, Kmart. Woolworth, by contrast, tried to maintain its pace of investment in its traditional stores while building its discount-retailing arm, Woolco. Despite the fact that Woolworth was far larger and had much deeper pockets, Woolco – and ultimately all of Woolworth's variety stores – folded. The lessons for today's medical institutions: don't be scared to invent the institution that could put you out of business, and stop investing in dying business models.

Overcome the inertia of regulation. Attempts to use regulation to stave off disruptive attacks are quite common. The U.S. automakers, for example, relied on import quotas as long as they could to keep disruptive Toyota and Honda at bay. Unfortunately, regulators are inclined to be even more protective of the entrenched professions and institutions in health care than they were of the U.S. automakers. The links between those institutions, federal and state regulators, and insurance companies are strong; they are wielded to preserve the status quo. (Nothing else could explain why nurse practitioners are forbidden from diagnosing simple illnesses in so many states.)

Instead of working to preserve the existing system, regulators need to frame their jobs differently. They need to ask how they can enable disruptive innovations to emerge. Let's return to the example we began with – the low-cost X-ray machine. Suppose the regulators wanted to see this disruptive innovation work in doctors' offices but were concerned about potential risks. They might require that all images interpreted in a physician's office by a nonradiologist be transmitted via the Internet to a second-opinion center, where skilled radiologists could confirm those initial diagnoses. Admittedly, that would require a massive change in the way regulators do their work.

The Need for Leadership

Once an industry is in crisis, individual leaders often become paralyzed. They're incapable of embracing disruptive approaches because the profitability of the institutions they lead has been so eroded. Typically, not only do they ignore the potential disruptions, they actively work to discredit and oppose them. Thus far, this pattern has held true in the health care industry as well.

Successful disruptive revolution of this system will unfold more quickly, and far less painfully for everyone, if leaders at regional and national levels work together – not to regulate the existing system but to coordinate the removal of the barriers that have prevented disruptions from happening. Unfortunately, in this presidential election year, the proposals from both leading parties for dealing with the crisis in health care have been molded within the established system. These proposals can be divided into three categories of solutions: control costs by consuming less health care; impose reimbursement controls that force high-end providers to become more efficient; and use government money to subsidize the high costs of health care for targeted segments of the population. None of these proposals addresses the fundamental causes of the dilemmas that the health care system faces.

Government and health care industry leaders need to step forward – to help insurers, regulators, managed care organizations, hospitals, and health professionals work together to facilitate disruption instead of uniting to prevent it. If they do, some of the established institutions will fail. But many more health care providers will realize the opportunities for growth that come with disruption – because disruption is the fundamental mechanism through which we will build a higher quality, more convenient, and lower cost health care system. If leaders with such vision do indeed step forward, we will all have access to more health care, not less.

The authors express appreciation to Jeff Elton and his staff at Integral, Incorporated for their contributions to this article.

1. Clayton M. Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Harvard Business School Press, 1997).

2. See James Lardner, "For Nurses, a Barrier Is Broken," *U.S. News & World Report*, July 1998.

3. Richard A. Cooper, MD, et al. "Roles of Non-physician Clinicians as Autonomous Providers of Patient Care," *JAMA*, September 2, 1998. These market forces are already at work. It is estimated that by the year 2005, the number of nurse practitioners in clinical practice will equal the number of family physicians. Between 1992 and 1997, the number of schools offering qualification programs for NPs more than doubled, from less than 100 to approximately 250. During that same time, the number of students pursuing NP degrees quintupled, from 4,000 to over 20,000.

4. Evidence that specialists are already being disrupted in this manner can be found in a 1995 report by the Council of Graduate Medical Education, which predicted an excess of 115,000 specialists by the year 2000. See Stephen M. Shortell et al., *Remaking Health Care in America: Building Organized Delivery Systems* (Jossey-Bass Publishers, 1996), p. 298.

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Section 4: Change Management in e-Health

Do the Healthcare Professionals USE IT?

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Introduction

Information Technology is emerging in healthcare [1] but successfully implementing information systems in healthcare organizations appears to be a difficult task [2]. Information Technology is seen as an enabler of change in healthcare organizations [3]. Southon [4] suggests that (information) technology adoption decisions in healthcare are complex because of the uncertainty of benefits and the rate of change of technology [5]. This book tries to unravel this complexity and in this chapter we look at successful change management from a user perspective. Determinants on other levels may also be important, such the level project-management, the level of the organization, or even the level of the society [6]. On system-level, reimbursement structures, regulations and the existence of standards may have an explanatory role. On organization level, the previous strategic choices, strategic priorities, size and location of the organization and many other factors may play a role. Similarly, Kimberly & Evanisko [7] discuss such factors. On project level, resources, project management, etc. will play a role. No explicit attention on these factors will be given in this contribution.

Thornett [8] describes benefits as improved quality of care, disease prevention and disease management of chronic physical illnesses. Why then do, these systems not

diffuse into the health organizations? The adoption of information technology in healthcare has increased which underlines the importance of user requirements [9]. In later work she links the adoption to the activities of the healthcare professionals [10]. Fleisner and Hofkircher [11] refer to the same problem when they conclude that relevant information will not be improved unless additional requirements are met.

A multiple case study amongst 56 general practitioners (GP's) on the influence of resistance, relevance, requirements and resources on the introduction of an Electronic Prescription System (EPS) demonstrates that the EPS is not used in at least 72% of the cases. First, a broad background of the model is given. To explain the non-use of the system we combine the notions of information usage of Delone and McLean [12] and Davis [13] and the notion of innovation from Rogers [14]. We use the semantic ladder from Stamper [15] and information levels from Shannon and Weaver [16] to straighten them out (social, pragmatic, semantic and syntactic levels). To explain relevance we will build upon the notions of Saracevic [17]. This will be described in the definition and framework section. Together these concepts build up a framework for an interview model that we used in all cases as described in the case study method just before the empirical results. Finally we make conclusions for every determinant of the model.

Background

We can use a wide range of sources that discuss user-perspectives in IT-introduction. This section gives a short overview of intriguing literature. The aim is to demonstrate that "requirements" is not *the only* user-related determinant of user-adoption. Rather, it is an important determinant among other factors. One of the ultimate goals of our

research project in this field is to propose a model that neatly balances the role of such factors.

First, we present the dimensions of the USE IT-model to predict and evaluate innovation and diffusion of information systems: the innovation-dimension and the domain-dimension, which make four determinants for success: relevance, requirements, resistance and resources.

USE IT-model	*User Domain*	*Information Technology Domain*
Product	Relevance	Requirements
Process	Resistance	Resources

Table 1. The USE IT-model [18]

With process, we mean the innovation process is meant, similar to the process defined by Saarinen and Sääksjärvi [19] and the innovation process structure of Larsen [20]. The product is the result of this innovation process. This corresponds with the definition of the product by Saarinen and Sääksjärvi and the artifact structure in the framework of Larsen. Also the IT domain is part of the artifact structure; the user domain represents the organizational structure in Larsen's framework. The time horizon structure can be part of the requirements and the knowledge structure can be considered as an element of the resources.

Resistance is the personal attitude of all stakeholder groups towards the introduction of an information system [21]. The main IS-quality aspect of resistance is the attitude and the willingness to change. Pare and Elam [3] also focus on the attitude of the

professional when they assess clinical information systems. The end users have an important role because their norms and values determine the effectiveness of the information system.

Expectance of reduced quality of work life satisfaction, high complexity and the lack of trialability can result in resistance [14, 22]. Observability reduces resistance [14]. Leavitt [23] introduced four domains in which these risks will occur: tasks, structure, technology and people. Offenbeek & Koopman [24] connect people with resistance potential because they can feel that the quality of their working life will be decreased. Mumford [25] observed that user participation contributes to effective organizational change. When we focus on IT introduction more specifically, we again see a number of interesting literature sources. Thong & Yap [26] discuss the user-satisfaction approach to IT effectiveness. They mention the debatable operationalization, poor theoretical construct and misapplication as a result of the approach. On the basis of their review, they conclude that attitude is the construct that lies at the root of user-satisfaction, and suggest ways to improve operationalization and measurement of attitude. Paré & Elam [3] studied attitudes, expectations and skills in relation to physicians' acceptance of IT systems. Physicians with formal training on computers were more knowledgeable about informatics concepts and reported that computers would be more beneficial to health care, although it is not clear whether the training causes this attitude. Venkatesh et al. [27] however make the hypothesis that "attitude toward using technology will **not** have a significant influence on behavioral intention".

We argue this hypothesis in this chapter with previous results that resistance was found to be the cumulative effect of the other three determinants [28]. But attitude,

permission and capability of the end-user will influence the adoption apart from the other dimensions.

The *relevance* determinant is defined by Schuring & Spil [29] as: *"the degree to which the user expects that the IT-system will solve his problems or will help to realize his actually relevant goals"*. The word "expects" expresses that relevance is a factor that is important in the course of the adoption process, not only in evaluation. The word "actually" is crucial in their view of relevance. Relevance is not to be confused with the degree to which the user considers outcomes as being positive. The set of outcome-dimensions that someone considers "positive" is larger than the set of outcome-dimensions that are relevant. Imagine a physician, who basically considers IT-outcomes of a computer decision support system, such as, assistance in diagnosis, disease prevention, or more appropriate dosing of drugs, as "positive". This does not automatically imply that the IT-adoption is relevant to him; it is only relevant if these dimensions are high on his "goal agenda". Relevance defined in this way comprises relative advantage [14], net benefits [30], perceived usefulness [13] and job relevance [31], and results in task support satisfaction, which is a criterion for user satisfaction [22]. Also, it becomes clear that user-priorities regarding IT-innovations vary strongly. The functional uncertainty is often described in information systems literature. It occurs in the task domain of Leavitt. In each situation, the interpretation and the meaning can be different. Therefore, it is necessary to establish a functional specification with users and providers of the information systems. Henry & Stone [32] state this to be information quality. Larsen [20] notes however "the quality of the IS/IT product is a necessary but not sufficient prerequisite for IS innovation success. The *people* within the organizations determine the outcome." Within the healthcare

sector, Walley & Davies [5] conducted a study to the internal barriers to technological IT-advancement in the healthcare sector. The involvement of stakeholders is arguably one of the most distinctive characteristics of IT projects.

In their study on the implementation of an Electronic Prescription System Schuring and Spil found that lack of relevance was the major determinant that explained the failure of the implementation [28].

The *requirements* determinant evaluates the meaning of the information system. *Requirements are defined as the degree to which the user needs are satisfied with the product quality of the innovation* [33]. This includes such aspects as the functional capability, the ease of start-up and the ease of use.

Meeting the end-user's requirements results in high information quality, system quality [30], high interface satisfaction [22], and high compatibility [14]. There are instruments to identify user-needs, but Walley & Davies [5] question whether they are actually used. Van der Pijl [34] shows that there is more to say about people than just resistance or user participation. Both users and providers of information systems have their own targets, not necessarily going hand-in-hand. A central question is whether the provider intention is the same as the user interpretation [35]. We think that a requirements contract between user and provider can help to bridge the information gap [36].

Resources are defined as the degree to which material and immaterial goods are available to design, operate and maintain the information system [33]. The main focus of the determinant resources will be on the people and on the costs these people cause.

Next to that the reliability of the information technology and the information systems are

considered. Resources defined in this way refer to service and system quality [30], management support and mature IS function [19]. Resources (human, physical and monetary components, [37]) are needed to implement the new information system into the organization. The human resources can both be insufficient in time and in experience (risk of technology). Insufficient material resources [24] will have a limiting influence on the other three risk domains.

To measure the determinants the USE IT-tool consists of structured interviews. In this way a more precise insight can be obtained in the nature and relevance of problems and solutions, before implementation and this insight can be tested with the same tool during the evaluation of the implementation. In the next section we will elaborate each determinant of the USE IT model.

USE IT: Definition and Framework

Resistance

The tendency of human beings to resist and fear new and unknown things and the willingness to stick to the familiar procedures has been studied widely (e.g., [38, 39]). Attributing the rejection of innovations only to anxiety and fear of change, however, is an oversimplified view of the process of technology transfer [40]. Carey [41] finds a correlation between acceptance of change and variables such as previous use (experience), education, and current usage of a new system. She also reports commitment, exposure to change, and preparation for change as being important for successful implementation of new technologies and systems. So a much broader view on the subject of resistance is appropriate. We position it on the social level of the semantic ladder [15].

We start with the first known published reference to research on resistance to change in organizations by Coch and French [42]. They were early explorers in the world of resistance when they concluded, "by preventing or greatly modifying group resistance to change, this concomitant to change may well be greatly reduced". Besides taking notion of resistance influencing successful change they state that it can be different on group and individual level. Later change management literature categorizes into the individual, group and organizational (structure) levels.

On the group level, Lewin [43] refers to "group standards" when looking for reasons for resistance to change. He concludes that the more individuals take group standards of their environment, the greater will the resistance to change of an individual group member be. Lewin further continues that group standards with social values are often referred to as "social habits". The way to reduce the level of resistance may thus be either to diminish the strength of the value of the group standard or to change social habits itself.

Both Lawrence [44] and Zuboff [45] conclude that resistance is not simply an irrational phenomenon to be overcome [46]. Zuboff sees positive and negative aspects to resistance. More authors describe this healing effect of resistance [47-49]. Insightful and well-intended debate, criticism, or disagreement do not necessarily equate to negative resistance, but rather may be intended to produce better understanding as well as additional options and solutions. Rogers [14] also explains that it is perfectly rational to later adopter categories to be more hesitating about the introduction of an innovation; they do not have sufficient resources to overcome the consequences of a adoption-failure.

Kotter & Schlesinger [50] diagnose resistance from the negative viewpoint as:

- Parochial self interest (fear to loose something worthwhile [51]);
- Misunderstanding and lack of trust;
- Different assessments (believe that change is worthless [51]);
- Low tolerance for change.

Fuller [52] also discovers different levels of concern regarding resistance. Self-concern can be seen in awareness, personal commitment and personal consequences. Task concern is related to controlling the change and cooperation concern sees both concerns in collaboration and reengineering. Schmidt et al. [53] whose study was a mirror of control for this study refers to Zmud [54] who adds a fourth environmental category. Lapointe et al. [55] applies these categories in explaining the dynamics of IT adoption in healthcare. She based her theory on the theory of reasoned action where "individual behaviour is directly determined by one variable-intention-which, in turn, is determined by two variables: attitude and subjective norms". In line with Scott [56], Prasad and Prasad [57] make the distinction between formal and informal (routine) resistance. Strebel [58] already described this as personal compact, formally a job description and appraisal but informally psychological (mutual expectations) and socially (cultural values). This brings us back to the notion that change is intensely personal [59] and therefore our empirical material is gathered very close to professional coping with the change.

Kotter & Schlesinger are mainly interested in the self-concern. Mittelstaedt et al.[60] adds the inability of either individual or group to cope with the change. Also the

situation can call for postponement. The situational factors we see as mainly emerging on organizational level:

1. Not for them (reject)
2. Unwilling or unable (accept)
3. Postpone (time and situation) (accept)

Gatignon & Robertson [61] and Szmigin & Foxall [62] use sort like distinctions, the latter introduce opposition instead of unwilling or unable. Ram and Sheth [63] call this habit resistance and also relate to Rogers [14] when they state that often an initial resistance has to be overcome. Please note that most of the literature in this paragraph is based on resistance of consumers. It might not always apply in a healthcare environment.

Offenbeek & Koopman [24] introduce the resistance potential and make a distinction between change-ability of the problem system and desired change. This potential of resistance would be people-determined resistance according to Markus [64]. System determined resistance is handled in the technical determinant of IS success but the interaction determined resistance which is mainly political (inter)organizational resistance can only be seen within the reasons to postpone of Mittelstaedt et al. [60].

Other publications on the subject of resistance challenge or enhance the "accepted" concepts [65]. Piderit [48] suggests that resistance to change is a complex, multidimensional response with emotional, cognitive, and intentional components. For example no participation or not enough communication may result in an emotionally resistant attitude to the changes, even though the changes make good business sense (cognitive). Alternatively, initially enthusiastic (emotional) and clearly

seeing the need for change (cognitive), people give up (i.e., our intentions change) because they are not given the support they expect and think they'll need in order to make the changes happen. It is rare that employees are all negative or all positive across the three dimensions. It is important to remember that resistance to change is normal and frequently functional.

"Moving too quickly toward congruent positive attitudes toward a proposed change might cut off the discussion and improvisation that may be necessary for revising the initial change proposal in an adaptive manner." In other words, discussion, disagreement and experimentation consistently can lead to more successful change, whereas effective communication and participation are powerful tools for overcoming and avoiding misunderstandings [49].

Zaltman and Duncan's [66] resistance framework discusses four categories of barriers, "cultural, social, organizational, and psychological" that can obstruct change. These categories are in turn broken down into a total of eighteen resistance factors, which disrupt change efforts and distort adopter perceptions of innovations.

This framework can be useful because it explores change from the opposite perspective to most other models. By focusing attention on factors that erect barriers to change, Zaltman and Duncan help to recognize such obstacles as they arise or even to identify and address their underlying issues before they arise. It is important to note that a given individual can harbor intense pro-change and pro-resistance sentiments simultaneously.

Though detailed in its 18 factors, this framework is not suitable for the goal of this study. More appropriate is a model with its roots in change management, educational

and training literature, structuring resistance and affection into three categories: Ability, Attitude and Opportunity. Metselaar et al.[67] describes this used in training against (negative) and with (positive) resistance based on a concept from the social psychology [68]. Lanning [39] comes with the same result in an empirical study for a planned change approach. We adopt these findings into our "USE framework for resistance to IT change" where we should reckon that the main focus of these shifts from (inter) organizational, to group, to individual. In line with the USE IT model [21] this subdivision is made into macro and micro resistance (see figure 1).

Attitude (Will) to change (Micro Resistance)

People who are expected to participate in the change project must have personal motivation and a sincere will to engage themselves in the development. Comprehension and acceptance of the basic idea in the project is an important condition. Will does not occur unless real effort at developing the organization can be perceived.

Ability to change (Macro Resistance)

The level of knowledge and skills of those who are involved in a "change" project needs to be high enough to be able to contribute to the project. Job specific skills enabling people to use new tools and technology and to act according to new procedures and tasks must be adequate. But ability also means comprehension of project vision and understanding one's own role in implementing the new technology. The user experience also adds up to his ability to change.

Opportunity to change (Macro Resistance)

There is a need for organizational systems (surrounding people and structures) to support the development process and implementation of the new technology. Sufficient resources, top management support and commitment are essential to give everybody the feeling that change and development can be achieved.

These sub-dimensions of resistance fit underneath the user satisfaction research model of Mahmood et al.[69] as they call it user background and organizational support. The perceived benefits that complete the user satisfaction are in the USE IT model situated under the relevance determinant [70] and described in the next section.

Relevance

Saracevic [17] defines relevance as a measure of the effectiveness of a contact between a source and a destination in a communication process. This is a somewhat abstract wording of what we would call the degree to which the user expects that the IT-system will solve his problems or help to realize his actually relevant goals. There are three dimensions that are kept implicit in Saracevic' definition that we wish to stress. We use the word "expects" since we want to make more explicit that relevance is a factor that is important in the course of the adoption process, not only in evaluation. Second, instead of effectiveness we use "solve problems and goals". By doing so, we imply that effectiveness has two dimensions: to take away existing negative consequences (problems) and, to reward with positive consequences (reach goals). Third, the word "*actual*" is crucial in our view of relevance. Relevance is not to be confused with the degree to which the user considers outcomes as being positive. The set of outcome-dimensions that someone considers "positive" is larger

than the set of outcome-dimensions that are relevant. Imagine a physician, who basically considers IT-outcomes of a computer decision support system, such as, assistance in diagnosis, disease prevention, or more appropriate dosing of drugs [8], as "positive". This does not automatically imply that the IT-adoption is relevant to him. It is only relevant if these outcomes are high on his goal agenda. That is why we use the word actual. Again, this is a more explicit wording of a dimension that is implicitly included where Saracevic uses the word effectiveness in his definition. The actually relevant goals may be a mix of short-term goals and long-term goals. If, for example, smooth communication with hospitals or pharmacy is his prime actual problem or goal, he will only consider the IT-innovation as relevant when it actually helps to improve that communication, notwithstanding the fact that he might have a positive attitude towards that innovation as long as the innovation helps to solve other problems or other goals that are on the lower positions in his agenda-ranking. We discovered in our case studies that it is not sufficient for an innovation to effectuate a positive attitude amongst users. The IT-innovation should be relevant [29].

Micro-relevance is a related concept that can be used to describe a similar phenomenon once the new IT is installed. Micro-relevance is defined as "the degree to which IT-use helps to solve the here-and-now problem of the user in his working process". The use of new equipment or new IT-procedures is a conscious activity. In every conscious activity that is goal-oriented to a specific goal, there is a reason why that course of action is being chosen. Similar to what was discussed above on "relevance", not every course of action that a user basically considers as "positive" is "micro-relevant". Again, let's illustrate this with an example. Imagine a patient with a virus infection visits a physician. The physician might notice the similarity to a

number of other patients he has met that week and decide on diagnosis and treatment fairly quickly. To this doctor, the use of a decision support system to determine diagnosis is not micro-relevant. However, a colleague of his may not feel so confident and thus use the system. We discovered that micro-relevance is a key factor in explaining IT-use in our case studies. Figure 1 gives an overview of relevance as we propose to use it.

Relevance and micro-relevance are notable refinements of the way the role of the user is being discussed in the existing literature. Thornett [8] implicitly refers to relevance and micro-relevance when he discusses limited adoption and use of DSS by primary physicians where "consultation time is lengthened by their use and there is no appreciable impact on patient satisfaction". It is an example where other outcomes that are basically considered as positive (as mentioned above: better diagnosis, more appropriate dosing of drugs, and other) are overruled by limited relevance and micro-relevance.

Saracevic [17] provides a historic positioning of relevance. The roots lay in the 1930's and 40's when the distinction between information and relevant information was made by Bradford [17]. In order to make the distinction between relevant and non-relevant information, he discusses the nature of communication. By doing so, he recognizes that relevance to a subject depends on specific dimensions, like for example, the subject's knowledge, representation and values. He discusses a number of (philosophical) approaches to relevance. The elaboration we propose above builds on the radical pragmatism-perspective or, more specifically, Cooper's [71] utility function "Relevance is simply a cover term of whatever the user finds to be of value

about the system output, whatever its usefulness, its entertainment, or aesthetic value, or anything else". Wilson [72] adds to this that relevance is situational. Ballantine et al. [73] put it in the following way: "Depending on the type of task, the information generated by the system may be more or less appropriate, which will affect its success or failure". Saracevic [17] distinguishes various other approaches to relevance, of which a number focuses on the basic source of relevance, like, logical relevance, the nature of interference and the pertinent view of relevance. We are very much aware of the fact that our elaboration of relevance does not in full retains the differences between those point of views. It is merely a practical elaboration that we use to predict user-adoption.

The pragmatic perspective [74] of relevance that we choose resembles the notion of "relative advantage" as discussed in the Innovation Diffusion literature by Rogers. Rogers [14, 75] reserves a central role for "relative advantage", which is the user's view of "the degree to which an innovation is better than the idea it supersedes". Relative advantage can be economic or social. Rogers: "The nature of the innovation largely determines what specific type of relative advantage is important to adopters, although the characteristics of the potential adopter also affect which dimensions of relative advantage are most important". Based on a review of hundreds of empirical studies, Rogers concludes that relative advantage explains 49% of the rate of adoption of innovations.

It is most notable that the organizational factors are not explicitly included in our user-relevance framework. It should be kept in mind that the user's agenda of problems and goals depend on his role in society [76]. The influence of the

organization on this agenda depends on many aspects, including the involvement with other organizations, on time and on place. As a consequence, our framework reflects the actual impact that organizational goals and preferences have on the user, and thus, on organizational behavior.

USE Framework for resistance to and relevance of IT change	
Macro Resistance **Definition:** the degree to which the surroundings and locality negatively influences the users of IT → (Co)determines: IT-diffusion	**Macro Relevance** **Definition:** degree to which the user expects the that the IT-system will solve his problems or help to realize his actually relevant goals → (Co)determines: IT-diffusion
Generic sub-dimensions: **Opportunity**: Opportunity to change is the degree in which the users are forced or allowed to change **+** Budget available, clear objectives, top management support, social improvement **-** Decrease of autonomy, local effort for general gain, remaining old structures **Ability**: Ability to change is the change potential of the workers and the management **+** Training, education, experience and enough resources **-** Constraints beyond the scope of the user that prevent him from using the IT	**Macro Relevance** **1** Economic improvements **2** Social improvements **3** Functional improvements **4** Saving of time and effort
Micro Resistance = Attitude **Definition:** the degree to which IT-users themselves are opposing or postponing the IT change **1** Parochial self interest **2** Misunderstanding or lack of trust **3** Different assessments **4** Low tolerance of change	**Micro relevance** **Definition:** the degree to which IT-use helps to solve the here-and-now problem of the user in his working process **1** Absolute value of relevance **2** Here and now value **3** Low initial costs **4** Immediacy of the reward

Figure 1 – USE Framework for resistance and relevance

Requirements

At the semantic level [12, 15, 16] we are concerned with how pattern-types relate to what happens in the world. On this level we deal with the meaning of the system but this term brings along a lot of different meanings about its definition [77]. The meaning of a sign relates to the response the sign elicits in a given social setting [78]. It is situational of nature since we have a range of pattern-types that signify a certain meaning and a user (group) that interprets the expression [79]. Therefore it is necessary to establish requirements as thorough as possible. Wieringa [80] defines requirements as *desired properties needed to achieve the desired composite system properties.* Pressman [81] makes a distinction between normal requirements, expected requirements and exiting requirements. Before defining requirements ourselves we want to study the problem at a deeper level.

'Many system designers do not appear to realize that with their present approach they are designing only partial systems' [25]. She argues that all needs of the end users should be identified. The notion of variance emerged from some early socio-technical work design experiments in Norway [82]. A variance is defined as *a tendency for a system or subsystem to deviate from some desired or expected norm or standard.* Key variances are the deviations on goals and functions, operational variances stem from the organizational problems. Together they get close to the main problem that we are addressing, the information gap between designer and user.

Iivari and Koskela [74] include three quality constructs on the semantic level, which they call the input/output requirements: informativeness, accessibility and adaptability. Informativeness describes the potentiality of the information systems,

accessibility the quality of the user-IS interaction and adaptability points to the ability of the systems to change.

DeLone and McLean [12] enumerate the criteria for IS success from nine earlier studies. They declare themselves that there is not "one" measure of IS success but there are many dependent variables. They call their taxonomy on semantic level information quality. Usefulness or relevance is mentioned eight times in the nine studies. Schuring and Spil [29] have studied the importance of relevance and made it a separate determinant on the pragmatic level. Timeliness is empirically used five times and adopted in our model. We keep using the term accessibility as a broader term including convenience of access. Accuracy is studied four times and adopted under informativeness. We do not understand why there is no notion of adaptibility or ability to integrate in the DeLone & McLean study. We adopt ability to integrate as the degree that the new system is imbedded in the organization.

Brender and McNair [83] use the ISO 900x structure and use the strategic, tactical and operational level to perform their user requirements specification. Larsen [20] also makes this distinction. The strategic level is concerned with the problem definition, including objectives and global task description. The tactical level is interpreted as a preferred approach and the operational level includes a set of functional, performance and capacity criteria.

The Requirements determinant is defined as *the degree to which the user needs are satisfied with the product quality of the innovation.* We divide the requirements into macro and micro requirements (see figure 2):

- Strategic general requirements and tactical approach is the degree in which the users agree with the objectives and methods used.
- Functional requirements and performance requirements specify what the content of the innovation should be. In this study we chose timeliness (accessibility), accurateness (informativenes), ability to integrate and content as main quality criteria but we acknowledge that this is specific for this study and not a complete list.

Resources

Under the semantic level most researchers situate the syntactical level [74]. They give efficiency criteria to measure the quality of the information system on this level (design costs, operations costs and maintenance costs). Shannon and Weaver [16] call it level A, the technical problem and Stamper [15] divides it into three levels (syntactic, empirical and physical). Main quality criteria on these levels are formal specification, reliability and costs.

The Resources determinant is defined as *the degree to which material and immaterial goods are available to design, operate and maintain the information system.*

The design costs can mainly be seen as time and capability of users and designers [84] but also the size of the project and the complexity of the problem could be measured to assess the risk of the innovation design. Also hardware and software costs fall under this header. Formal specification on syntactic level can be checked on semantic level with the quality criterion accurateness (data, system and information).

The operations costs are mainly human resources but the abnormal costs can be derived from the reliability of the system [74].

The maintenance costs can be shown with the quality criteria adaptability and portability that also link to the ability to integrate on a higher level.

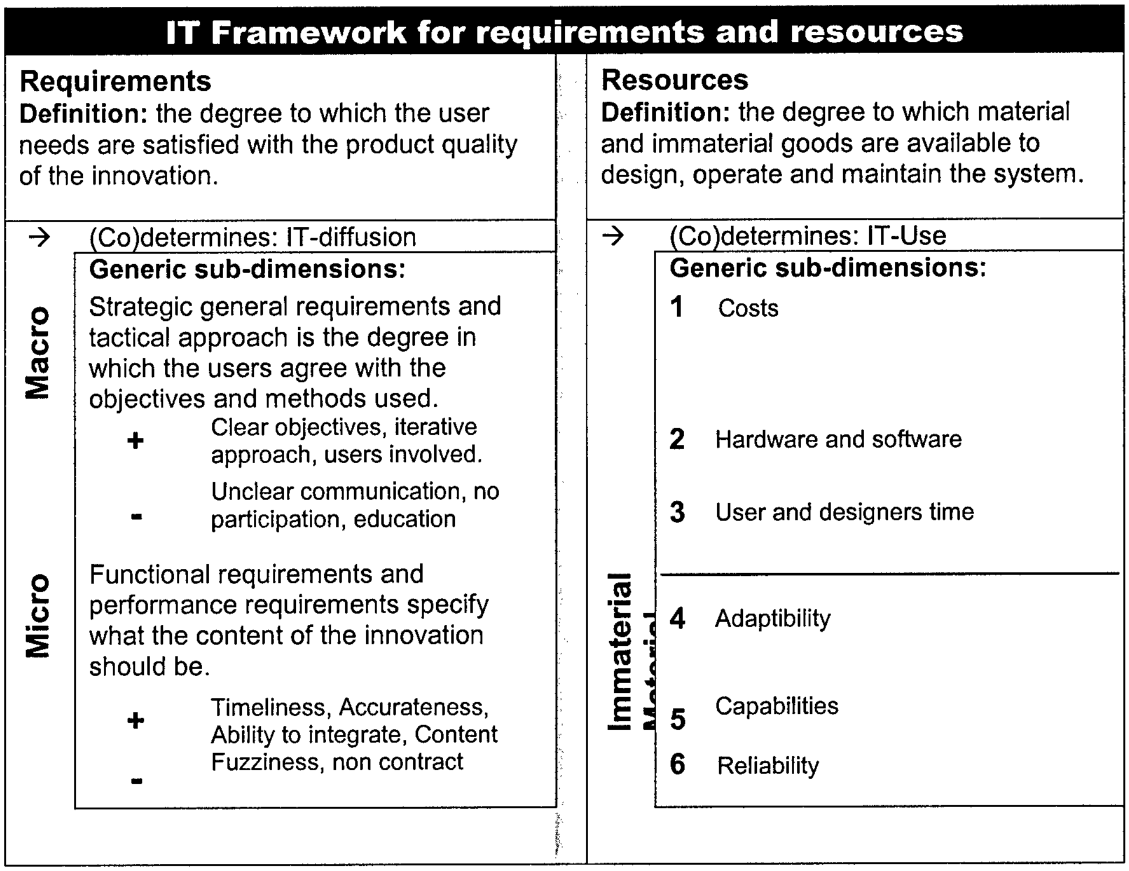

Figure 2 – IT Framework for requirements and resources determinants

Multiple case studies results

Case Study Method

Nykänen [85] distinguishes four major evaluation perspectives: goal-oriented, standardized, effectiveness-based and stakeholder-based perspective. In the goal-

oriented evaluation the emphasis is on rationality: measurement criteria and means to achieve the goal can be derived from the goal itself. This is possible if the criteria are clear and there are no conflicts of interests among the stakeholders. The downside of goal-oriented perspective is the inability to see other than the anticipated consequences of actions. In the standardized (or normative) evaluation, causes and consequences are not in the scope of interest, but compliance with rules, agreements, budgets and principles, is monitored (e.g. quality systems). In effectiveness-based view the input/output ratio of actions is economically evaluated. The problem with this perspective is in expressing intangibles (e.g. health) in monetary terms. According to the stakeholder-based perspective, all actions are not always rational, aiming at one mutual goal, and therefore the criteria should be collected from several stakeholders' view. The perspective has a lot of qualitative characteristics and it can be a quite laborious framework for a study design [86].

This study used the stakeholder-based perspective and was set up to both assess the situation regarding the electronic prescription system "EVS" in the Netherlands and the theory that is described above, that was set up to provide an instrument that could be used to analyze the diffusion-situation of the prescription system. This resulted in a case-study protocol that covers all the topics that are mentioned in the framework in open-ended questions. In line with the case-study approach by Yin [87] we discerned different case-situations on the basis of our theoretical framework. Particularly, the network-situation (individual, group practice, health-care center) of general practitioners and the degree of adoption of previous ideas (laggard (no computer) to innovator (using ICPC codes and electronic patient record)) served as a basis to make categories of general practitioners. A total of 56 case studies were conducted. Each general practitioner was visited in his/her own working situation and interviewed for

over an hour. We agree with Brender [88] that the kernel point of assessment is that of understanding the business processes.

Electronic Prescription in The Netherlands: an introduction

The Electronic Prescription System (EPS) that we studied is an IT-system that gives general practitioners recommendations on the therapy that can be given to patients on the basis of the diagnosis of the practitioner [89]. This diagnosis is coded by use of the International Code for Primary Care (ICPC). The value of the system, as compared to the traditional situation, lies in the fact that the system takes characteristics of the patient into account. The recommended therapy is customized on the basis of the age and gender of the patient, existing pharmaceutical therapy for other diseases and is based on the formulary, which is a list of drug-preferences that is set up by professional associations. Figure 4 shows the working principle of the EVS.

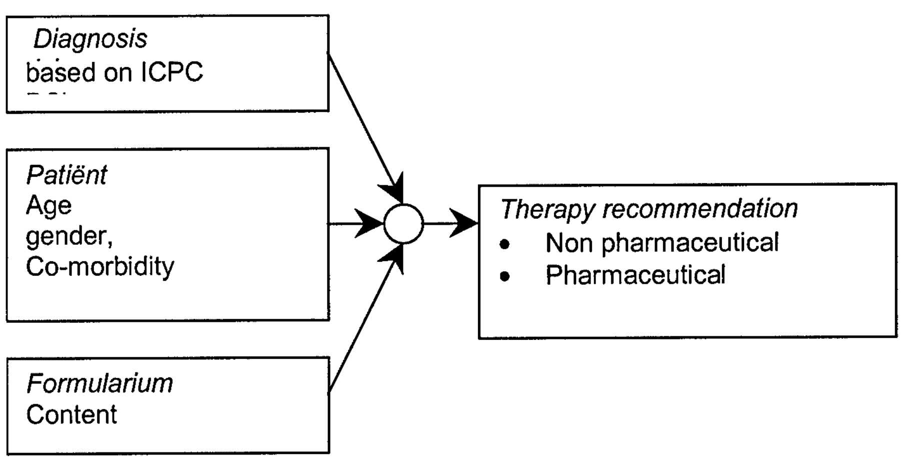

Figure 3 Working principle of the EVS electronic prescription system

The EVS is available as an add-on to practically all information systems that exist for GP's in this country (GP IS).

Empirical results GP electronic prescription system

Empirical Resistance of GP

The main problem formulation for this study was to find the obstacles of implementation of the EPS system. Under the header resistance of the GP, questions were asked about problems or wishes that the GP experienced as important at the moment of asking, during implementation of the Electronic Prescription System. Figure 1 gives an overview of all the situational resistance factors mentioned. Here we will summarize the results of the main five:

- Time (55%)
- User interface 33%
- Free choice 30%
- ICPC 27%
- Unwilling 20%

Fifty five percent of the GP's said to be under immense time pressure. We think that this made the EPS less relevant to the GP's [70] but it also levered the resistance because the GP's thought they would need more time for a consult using the EPS in stead of less time. These statements are confirmed by British research [90].

Thirty three percent of the GP's had problems with the quality of the software. Main problems were not related to the new EPS but more to the old GP IS that was not able to give a good user interface. The EPS we described in [91] as "spoilers on a T-ford".

Thirty percent of the GP's say they do not want to be written the law by a new system and want to remain free choice in prescribing drugs to their patients. Some say the advises are too conservative, others say they want to be able to try out new ideas. All of them say they want the freedom of choice.

Twenty seven percent of the GP's thinks that ICPC, -the international primary code-, is a problem when using the EPS system. Some state that it is rather difficult to find a related ICPC to the diagnosed disease. Other state that it is not necessary to use ICPC for general diseases like flue because it costs time and it does not help the process.

Twenty percent of the GP's is unwilling to use the EPS. That means that they have not looked at it and will not look at it just because they do not like the change. Here we see clearly a low tolerance of change.

Empirical Relevance to the GP

Under the header relevance for the GP, questions were asked about problems or wishes that the GP experienced as important at the moment of asking, during implementation of the Electronic Prescription System. Figure 3 gives an overview of all the situational relevance factors mentioned. Here we will summarize the results of the main seven:

1. Communication
2. Time
3. Money
4. Software

5. Free Choice

6. International Code Primary Care (ICPC)

7. Formulary

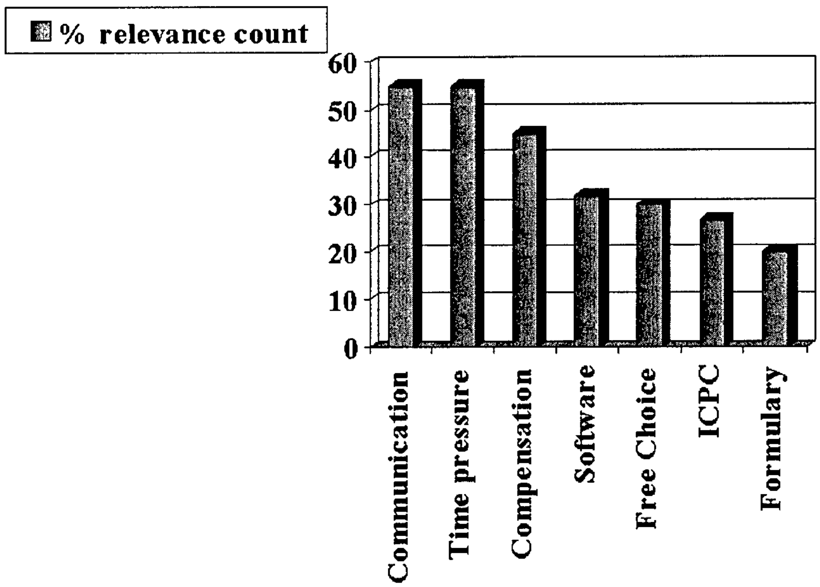

Figure 4 – Multiple case study results on relevance

In more than half of the case studies, the GP's said that improvements have to be made to communication with colleagues, pharmacists and hospitals. They state that a standard way of working is very important to reach such a communication. The EPS system does not deliver these features. Saarinen and Saaksjarvi [19] measured the improved internal communication and improved inter-organizational communication under the header "impact of the IS on the organization". None of these success factors was satisfied in our cases.

In fifty five percent of the case studies and independently of each other (the term was not mentioned by the interviewee) the GP's stated that there should be a diminishing of the time pressure. Both in the description of the EPS, as in international literature it is made assumable that EPS will not diminish the time of the consult [8, 90].

Forty five percent of the case studies reported that the GP expected a fee in return for going through the trouble of implementing and using EPS. At the moment of interviewing it was not clear what financial profit the new system would deliver for the GP. What was known was that it would save the government and insurance companies a large amount of money on costs of medicine.

In about twenty case studies lack of trust in the existing software and in the software supplier were mentioned as a barrier for (wanting to) use the new EPS. They said that first things had to change in the GP-IS market and in the GP-IS itself before EPS could be a success.

About the same amount of GP's want to remain freedom of choice for medication of the patient. Although this seems to be a resistance matter it is also a relevance matter because the EPS does not comprehend new ideas and new treatments that are already known in the general practice.

Although the use of ICPC seems useful to many GP's (in structuring and communicating) the time that it will cost to find the right code and the omissions of some codes form a barrier for EPS use.

Twenty percent of the GP's make use of a personal or regional formulary. The EPS makes use of a formulary of the Dutch council for GP's and often does not have the possibility to keep the own formulary when an update of the software is installed.

Finally, once the computer-system was installed, use of the system was mostly sparse. The way of working was relatively complicated and added relatively little value in most patient-doctor contacts.

Empirical Requirements to the GP

General requirements

The objectives for this innovation were mainly money driven. The system should decrease prescription costs with 150 million euro yearly. To the GP's we interviewed, the goals were not clear.

Functional and Performance Requirements

Content

The functionality of the GP information system can be divided into administrative functionality and medical functionality. We observed that the administrative use of the system has the overhand. Only 15 GP's (27,3 %) made use of the SOAP (subjective, objective, assessment, plan) module in the systems which is a prerequisite for the use of the electronic prescription system.

Communication with other GP's, hospitals and pharmacists is a requirement that is high on the agenda of the GP (55%). Still, the new EPS does not support the communication at all.

Timeliness

Time pressure is one of the most important problems of the GP today. Timeliness of the system is therefore an important performance criterion. Due to a bad user interface the GP's are not able to work several records parallel and therefore loose time in opening and closing the patient's record.

Accurateness

The accurateness of the system is good and might be too good. The system was rigidly designed to avoid failures and therefore has many signal functions. For instance, when prescribing medicines for influenza, the GP gets a lot of alternatives and warnings where he or she already exactly knows what to prescribe.

Also the accurateness of input is a problem because 30 percent of the GP's think it is unnecessary and sometimes difficult to generate a code for all "vague" diseases like stomach ache, headache and so forth.

Ability to Integrate

The electronic prescription system is delivered on CD-ROM as a stand-alone system. This means that it is not integrated in the GP information system and also not in the communication configuration of the GP. The GP therefore has to start the program for each patient and cannot work parallel even more because the system is not window based.

Empirical Resources to the GP

Costs

For the GP's there are no costs involved in getting the system but they need to time to install and operate the system. In general 30 million euro was spend in designing and implementing the system. Strangely all system suppliers said they did not get money to change their GP information system. The operating and maintenance costs are not seen as a problem by the GP. The reward for using the system is seen a problem. Extra office support was promised by the government but in practice not given and not clear.

Hardware and Software

The GP's have no faith in the suppliers of GP information systems. Caused by fusions and take-overs, the suppliers and GP's are in a deadlock situation where maintenance seems to be the only thing that happens. Thirty percent of the GP's call the quality of the GP information system an obstacle for using the new EPS. We described it as "spoilers on a T-Ford".

User's and designer's time

From our questions to the GP's it is very difficult to analyze the time spend in designing the system. In operating the system the GP loses time because he or she has to put more information in the computer and uses some time in consulting the system. With an average time of 6 minutes per consult this is a big problem.

Adaptability

From maintenance point of view, the system is very adaptable since a new version just has to be distributed without having to change the rest of the GP systems.

Nevertheless we advised that the GP system itself had to be updated with the EPS as an integrative communicative subsystem within.

Capabilities

One of our final conclusions in the main report [91] is that we think it is crucial in the continuance of the project that the average GP is addressed instead of the innovative GP. In designing the system GP's were involved but only voluntary GP's that are bound to be pro bias focused.

We also found big differences in IT capabilities. Some GP's still used the paper record and no computer and some GP's did all their activities on the computer. Different introduction scenarios therefore are needed to diffuse the system into all GP practices.

Reliability

According to the General Practitioners, the system is reliable. Breakdown of the systems seldom occurs. The maintenance is reasonable although one GP states: "We have to be at a patient's house in 10 minutes and they can stay away for 10 days".

Conclusions

Resistance of GP's is not **the** determinant of the use of the EPS (only 27%). Resistance is the cumulative consequence of effects of the other determinants and therefore it looks as if resistance is the most important determinant. This means that many studies work on the effect and not on the cause of the lack of IT use.

Relevance has long since been a central notion to IT-theory. The elaborated approach that we proposed in this paper was used in 56 case studies. These cases provided us with enough evidence that for this particular (electronic prescription) system in this particular (healthcare) branch, relevance was the most important determinant for failure of diffusion and use of the system.

Although in many studies the social criteria of success are mentioned as more important than the technical criteria we cannot confirm this for these 56 cases. In most cases the resources were not sufficient to use the new electronic prescription system. On top of that the requirements of the users were not sufficiently met by the system. We like to draw the following conclusion for the healthcare organizations:
Before starting a new project to build or buy a new information system in healthcare organizations it is necessary to explicitly measure the resources available. Next step is to make a contract containing functional and performance requirements both agreed upon by a broad (laggards and innovators alike) group of end users and the responsible designers of the system.

Finally, we can conclude that assessing the IT diffusion and IT use of the electronic prescription system with the USE IT model was a multiple case study balancing the socio-technical determinants. The model has been used in two other healthcare situations and is now been used in a telecare project for stroke patients and a diffusion project of an electronic patient record in a hospital. We stimulate other researchers to work with the model in other environments (also outside healthcare) and encourage the use of the interview schedule.

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Appendix

Interview-protocol Care Provider USE IT version 14.0

Date interview:	
Name interviewer:	
Name interviewee:	
Job interviewee:	
Organization:	

P	*Primary process*
P1	What care do you provide? Most care providers contribute to different care processes. In our research we make the following distinction: • Diagnosis % • Investigations outside the consulting room % • Treatment % • Nursing % • Acute incidents occur: the whole day through / several times a day / several times a week • Acute incidents dominate my work very much / somehow / a little / not The categorization may be adjusted to the investigated care process as long as it is clear to what % of patients or tasks the innovations applies (see Rel. 7). How do you act at each of the above-mentioned tasks? • Do you follow a fixed pattern? • How long does a patient contact take? • Do you use equipment? • Do you use (human) support? If so, for whom else does this supporter work? • Where do you perform your tasks? Could they be performed elsewhere? • Do you always sit or stand in the same position towards the patient? (Make a sketch) • Do you have to look up or ask after things? • Do you have to prepare anything?
P 2	What other tasks do you have apart from providing care? How much time or energy do these tasks take from you? time % energy %
P 3	What exceptions or disturbances make that this kind of care or the coordination of this care fails?
P 4	Do you use a care protocol or medical guideline for the care you provide? • Do you comply with this protocol entirely or partially? • What parts do you use, what parts don't you use? • Does using the protocol fit with your way of working?
P 5	Who refers patients to you?
P 6	To whom do you refer patients?
P 7	What other care providers or institutions are simultaneously involved with the care for your patients? • Do you work together? • Or do you work "in parallel"?
P 8	How do you experience the cooperation with other care providers in respect to the providing of the care?

P 9	With what care providers should you cooperate (more)? • Why? • With whom should you exchange more information? • What information?
P 10	What do you find important in the contact with other care providers?

REQ	***Requirements***
I 1	What information about the patient do you need to perform your job properly? (Distinguish according to the separate tasks, mentioned in P 1 and P 2) What information do you receive from • The patient? • The patient's surrounding? • Other care providers? • With what purpose? • In what frequency? What form does this information have? • Letter (sent by post or handed over personally) • Fax • E-mail • In paper record • In electronic record
I 2	Does this information suffice? • Do you experience problems? • Do you miss information?
I 3	What information do you generate yourself when providing care? What information do you give to: • The patient? • The patient's surrounding? • Other care providers? • Managers? • External parties (e.g., insurance company, government)? What form does this information have? • Letter (sent by post or handed over personally) • Fax • E-mail • In paper record • In electronic record • Record only used for this patient group or this type of care • Record only used by your own discipline • Record only used in your institution
I 4	How do you appreciate the quality of the proposed (or implemented) innovation? Regarding the: • Content • Objectives • Method • Possibility to integrate it in the present situation • Timeliness • Correctness
I 5	Where the right end-users involved with making or selecting this innovation?

REL	**Relevance**
R 1	What do you experience, **for you personally**, as important in your daily work when you look at the care you provide?
R 2	What aspects in the ability to provide care, do you experience as a bottleneck or problem? • Concerning the providing of care • Other aspects Are there any specific actions in the previously discussed processes that cause bottlenecks or problems?
R 3	Do you know proposals for improvement, concerning these patients, for which you would do your utmost?
R 4	How important are these proposed improvements in the chain of care in relation to other possibilities to improve aspects of your job? • Can you name other proposals for improvement, which are more important? • Can you name other proposals for improvement, which are less important?
R 5	In what way could the use of ICT matter to you? • What application are you thinking of? • For what purpose or for what situation?
R 6	What aspect of your job would you miss, if it would be removed?
R 7	How important are your tasks for these patients, **for you**, in comparison with your tasks for other patients? • Why are these patients so important or of so little importance for you?

Res	***Resistance***
A 1	To what extent are you convinced that the use of ICT is necessary to improve the providing of care? • What experience do you have with ICT? • How much time are you prepared to spend? • Do you use ICT to communicate? • How often do you use the Internet? • How often do you use specific systems yourself?
A 2	Do you experience obstacles when implementing innovations? • Workload • Management support • ICT support • Money • Your skills
A 3	How much time and energy do you think you can find to implement the changes that will occur when introducing innovations and ICT in this kind of care?
A 4	Do your colleagues or managers stimulate you to participate in changes?
A 5	Can you name other innovation-projects this organization is working on? • Are these projects equally important (or more or less important)?

Res	***Resources***
M 1	What ICT-facilities do you have at your disposal at your workplace? • Hardware • Software • For communication • Data
M 2	What of these ICT-facilities do you use when providing care? • Hardware • Software • For communication • Data

M 3	Is the technical support sufficient to guarantee the quality of the system? • Reliability • Availability • Security • Privacy
M 4	Do you think you will have support to implement changes? • Time • Money • Training • Management support

C	Concluding questions
C 1	Is there anything you would like to add?
C 2	May we contact you to think with us in the development of a ICT-application?

USE Framework for resistance to and relevance of IT change

Macro Resistance
Definition: the degree to which the surroundings and locality negatively influences the users of IT

→ (Co)determines: IT-diffusion

Generic sub-dimensions:

Opportunity

Opportunity to change is the degree in which the users are forced or allowed to change

- \+ Budget available, clear objectives, top management support, social improvement
- \- Decrease of autonomy, local effort for general gain, remaining old structures

Ability

Ability to change is the change potential of the workers and the management

- \+ Training, education, experience and enough resources
- \- Constraints beyond the scope of the user that prevent him from using the IT

Macro Relevance
Definition: degree to which the user expects the that the IT-system will solve his problems or help to realize his actually relevant goals

→ (Co)determines: IT-diffusion

Macro Relevance

1 Economic improvements

2 Social improvements

3 Functional improvements

4 Saving of time and effort

Micro Resistance = Attitude
Definition: the degree to which IT-users themselves are opposing or postponing the IT change

1 Parochial self interest

2 Misunderstanding or lack of trust

3 Different assessments

4 Low tolerance of change

Micro relevance
Definition: the degree to which IT-use helps to solve the here-and-now problem of the user in his working process

1 Absolute value of relevance

2 Here and now value

3 Low initial costs

4 Immediacy of the reward

Figure 1 – USE Framework for resistance and relevance

IT Framework for requirements and resources

Requirements	Resources
Definition: the degree to which the user needs are satisfied with the product quality of the innovation.	**Definition:** the degree to which material and immaterial goods are available to design, operate and maintain the system.
→ (Co)determines: IT-diffusion	→ (Co)determines: IT-Use
Generic sub-dimensions:	**Generic sub-dimensions:**
Macro Strategic general requirements and tactical approach is the degree in which the users agree with the objectives and methods used. + Clear objectives, iterative approach, users involved. - Unclear communication, no participation, education	1 Costs 2 Hardware and software 3 User and designers time
Micro Functional requirements and performance requirements specify what the content of the innovation should be. + Timeliness, Accurateness, Ability to integrate, Content - Fuzziness, non contract	**Immaterial** 4 Adaptibility 5 Capabilities 7 Reliability

Figure 2 – IT Framework for requirements and resources determinants

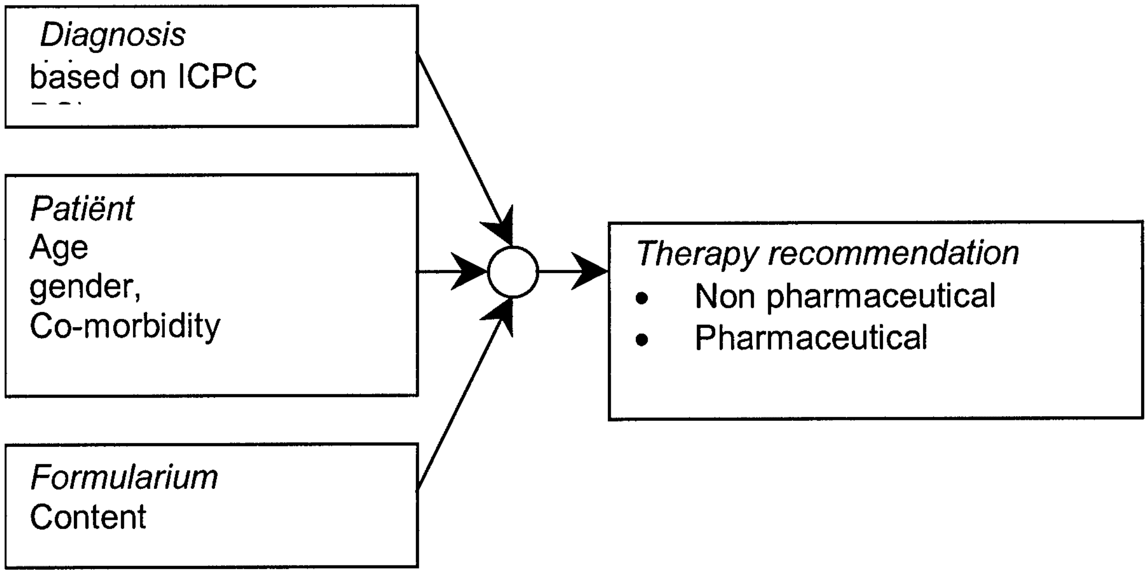
Diagnosis
based on ICPC
Patiënt
Age
gender,
Co-morbidity
Formularium
Content
Therapy recommendation
Non pharmaceutical
Pharmaceutical

Figure 3

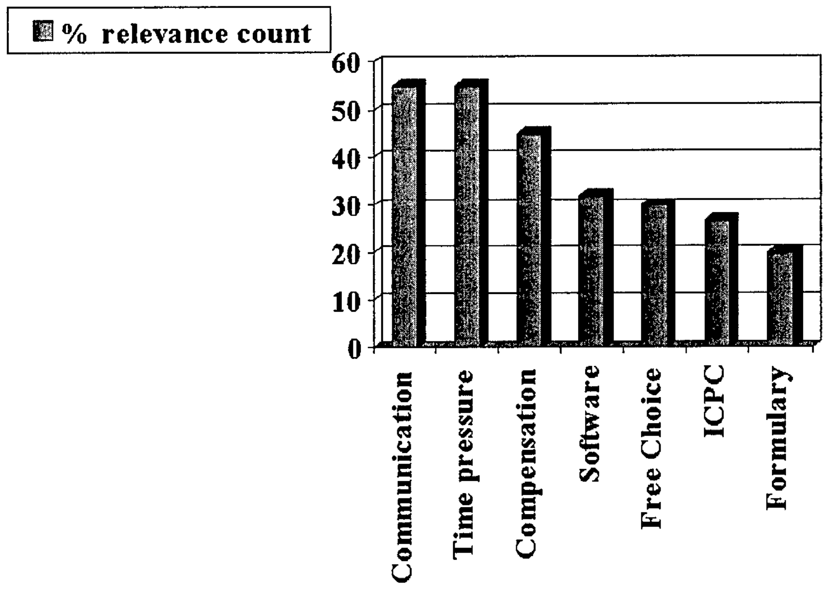
% relevance count
60
50
40
30
20
10
0
Communication
Time pressure
Compensation
Software
Free Choice
ICPC
Formulary

Figure 4

Implementation of a Telerehabilitation System using Change Management Principles

Pamela G. Forducey and Lori Smith

INTEGRIS Jim Thorpe Rehabilitation Hospital

Kawaljeet Kaur

Medical College of Wisconsin

Cynthia Scheideman-Miller

INTEGRIS Health

The need for alternative health care delivery models is real and critical. Innovative telecommunications technology has developed as a cost-effective strategy to meet the challenge of improving medical services to individuals. (1) One example of this type of technology is telemedicine, which is the use of electronic communication and information technologies to provide or support clinical care at a distance. A new term, telehealth, is often used to reflect the inclusion of preventative services in addition to diagnostic and medical treatment applications, and is one method that can reduce the limitations of our current health care system. As with any alternative delivery model, telehealth must satisfy the criteria of improving quality of life and achieving meaningful functional outcomes for individuals with chronic health conditions and resulting acquired disabilities. (2)

Rehabilitation is the process of restoring a person to a state of health or useful activity through training, therapy, and guidance. It is the observation of these authors that rehabilitation patients often receive intensive acute inpatient rehabilitation but frequently have access to only variable

and limited post-acute outpatient rehabilitation services, especially in rural communities. Integration of long-term care and other needed non-medical social services is often lacking, which is a significant concern to rehabilitation professionals since individuals with acquired disabilities such as brain injury or spinal cord injury often continue to improve throughout their lifetime. Given this reality, the efficacy of community-based, non-medical services/perspectives should be evaluated. These services include, but are not limited to, supported living programs, centers for independent living, case management services, supported employment programs, and telerehabilitation.

Telerehabilitation is defined as the remote delivery through telecommunication technology, of a variety of rehabilitative services for persons with disabilities. It is a versatile interdisciplinary medium that is used by health professionals to facilitate post-acute rehabilitation in the home and community settings. (3;4) Telerehabilitation interventions primarily occur in real time via two-way interactive audio-visual linkage, as opposed to a "store and forward" method. Nineteen different programs surveyed by the Office for the Advancement of Telehealth (OAT) in 2001 included some kind of telerehabilitation activity at their site. Services included occupational therapy, physical therapy, speech- language pathology, physiatry, psychology, audio-verbal therapy, and vocational rehabilitation. The majority of these programs are currently funded by federal, state or private grants. Long-term feasibility of these telehealth programs is dependent on the economic and organizational sustainability of the program.

Over the past three to four decades, multiple and diverse researchers have speculated why one organization is more likely to adopt innovation than another organization. A variety of factors

have emerged from economic, political, psychological, sociological and managerial perspectives. (5) The seminal study conducted by Kimberly and Evanisko (1981) focused on the health sector and identified factors to explain variability in the adoption of both technological and administrative innovations by hospitals. Data were collected from both hospital administrators and chief medical officers in each hospital surveyed as well as from the American Hospital Association Annual Survey of Hospitals. Individual (characteristics of hospital leaders), organizational (structural characteristics such as level of specialization and size) and contextual (competition in community and size of city) variables were found to be better predictors of hospital adoption of technological innovations than of administrative innovations. Comparative analyses also revealed that the education level of the hospital administrator, the size of organization, and the presence of competition in the local environment were significant predictors of both technological and administrative innovation. Organizational level variables, size in particular, were better predictors of both types of innovation than either individual or contextual level variables.

As we considered our own organizational initiative in launching a telerehabilitation program, several variables noted in this research contributed to our strategy and implementation approach. The most positive influences for technological adoption were the variables of organizational size, hospital administrative support, and functional success in the service line of rehabilitation. Despite our confidence in the administrative decision for advancing our mission through increased technological innovations, we also had to rely on our own experiences of prior change initiatives and lessons learned. The value of considering these lessons within the context of our organizational culture was critical. Prior experiences have taught us to plan early on for barriers

to success. As a result of these experiences, a teaching model emerged within our system in an attempt to become more efficient and effective in system change initiatives. This model assists our organization in both planning for barriers and providing hope for the endurance of the initiative.

Banner and Gagne (6) emphasize that there are common characteristics to all organizations: 1) goal direction; 2) identifiable boundaries; 3) social interaction; 4) structured activity and 5) culture. Our organizational system captured these characteristics and created components that we believed should be addressed throughout the life span of the telerehabilitation project to promote success. A visual model was developed that would serve as a pictorial guide to maintain our focus and balance. This model was instrumental to the implementation our telerehabilitation program in Oklahoma. These authors describe the implementation of the telerehabilitation program through focused effort on the five components outlined in Banner and Gagne's model. The five components of integrated organizational design, all of which should be addressed for a balanced approach to change, are *strategy* (goal direction), *structure* (identifiable boundaries), *people* (social interaction), *process* (structured activity) and *customer* (end user). The culture of an organization is the product of the interaction between these components. The customer is the hub around which these components interact and evolve. The interrelationship of these components is shown in Figure 1. All of these components can be traced to the different layers of the onion model described earlier in this book. Lessons learned during the process are included in the corresponding sections. Although this chapter focuses on 'change management', the third layer of the onion model, a successful change initiative is a multidisciplinary task, and cannot be dealt with in isolation.

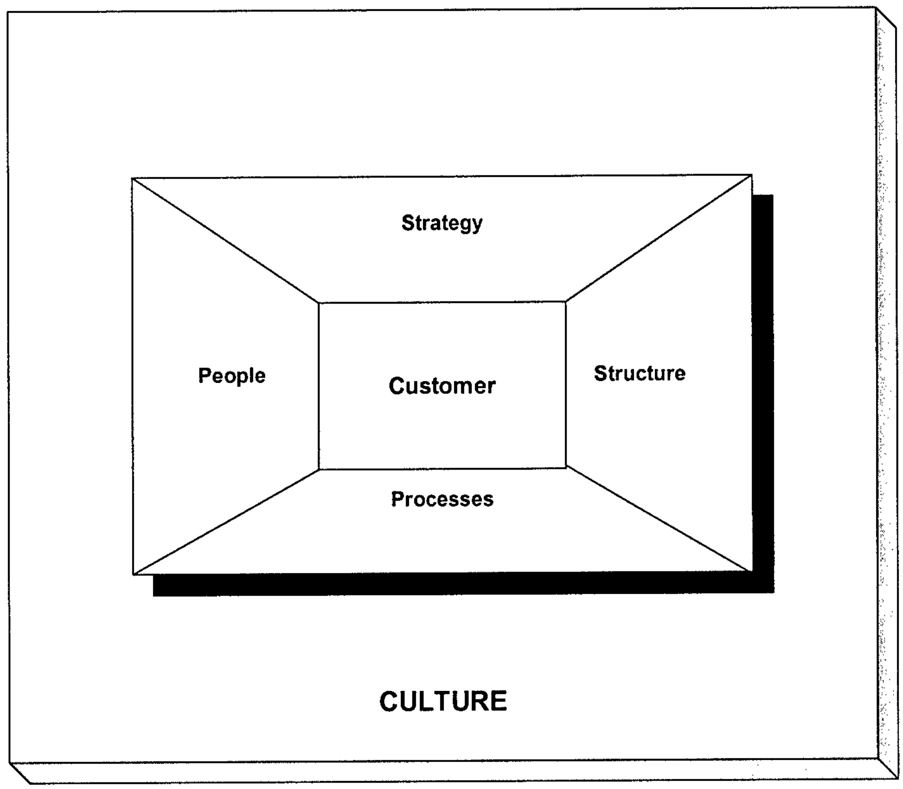

FIGURE 1
Interrelationship between Components of Change and Culture
INTEGRIS Health

Facility Background

INTEGRIS Health Inc. is an Oklahoma based not-for-profit health-care organization with hospitals, a rehabilitation hospital, physician clinics, mental health facilities, independent living centers, and home-health agencies throughout urban and rural Oklahoma. In 1993, Baptist Medical Center (BMC) created Oklahoma's first telemedicine network by connecting six rural INTEGRIS Health hospitals for voice, video, and data connectivity. In 1994, BMC went from a single hospital located in an urban area to several hospitals located throughout Oklahoma and became known as INTEGRIS Health. The INTEGRIS Telehealth Network (ITN) was built for

two primary reasons, CEO commitment and potential external competition. Since there was no provision for telemedicine reimbursement in 1993, the ITN primarily was used for continuing medical education (CME) and administrative and community-based services and was self-supportive with staff to cover it 24 hours, seven days a week.

INTEGRIS Rural Health received a rural telemedicine grant (1997-2000 and 2000-2003) from the Health Resources and Services Administration (HRSA), OAT to improve access to healthcare for rural individuals across the life span, reduce isolation of rural practitioners, and to collect and disseminate this data. The grant was used to expand the ITN sites, and provide medical primary care and specialist consultation. INTEGRIS Health expanded telehealth services to include analog based technology. They are currently partnering with a software company in a Rural Utilities Services grant in 2003 with a focus on disease management for patients in rural residences. The system recently converted to H323 (a multimedia teleconferencing standard) capable bridge, which expands its quality and capability. Today, evolving services are providing access to clinical information services (through Cerner applications), financial information and services (through PeopleSoft systems), and decision support (real-time Cerner decision support action). Teleradiology is active at four sites and will be expanded. INTEGRIS Health provides for ownership and maintenance of telemedicine equipment. From 1999 - 2003, INTEGRIS Health Information Technology (IT) received the Hospital and Health Networks Most Wired Award.

Needs Assessment for Telerehabilitation in Oklahoma

It is the supposition of these authors that telehealth is most likely to succeed if the healthcare needs of the community are not adequately met by conventional or traditional health care treatment modalities. Needs assessment should be a reflection of the organizational strategy, mission, and vision and is guided by the specific cultural and institutional context, which constitutes the first layer of the onion model. Executive buy-in is easier if the change complements the long-term strategic objectives of the organization. It should be noted that an innovative program such as telerehabilitation should be build on "demand" and not on "need". The need may be present, but it takes a demand for the service to generate business. Frequently, it is the health care consumers, individuals with disabilities and their caregivers, that are making the demands of their health care providers and insurance companies. The advent of the Internet has led to greater consumer empowerment and many individuals with chronic health conditions are assuming a more proactive role in the maintenance of their healthcare.

Oklahoma is a predominantly rural state with 63 of the 77 counties federally designated as rural. Rural patients receive fewer home health services and attain less favorable discharge outcomes as compared to the urban patients; a factor primarily attributed to resource constraints and a lower availability of skilled care disciplines. (7) Twenty-four of these counties are designated as medically underserved areas (MUAs), three counties are designated as health professional shortage areas (HPSAs), and 28 counties are designated as both MUA and HPSA. Telemedicine can be used in HPSA, MUA, prison inmates, school systems, long-term care facilities, Indian health centers, worker's compensation or self-insured industries, general population, and specialist consultation with other facilities. Seven of the 77 counties are designated as frontier

counties with less than six people residing per square mile. Besides the distance barriers, there are sociological and economic factors that play a part. The eastern part of the state primarily has agriculture and lumber industries. These lifestyle components expose people to a high risk of injuries with little local specialized services available for rehabilitation and recuperation. Since 1981, 15 Oklahoma hospitals, usually the sole hospital in their communities, closed secondary to low patient census and closure of physician practices. Twenty-three more rural hospitals are in danger of closing in the next three years. (8)

A comprehensive, coordinated rehabilitation program can reduce mortality and improve functional outcomes following an acquired disability. While such findings suggest longer periods of rehabilitation benefit the patient, pressures from third party payers to reduce lengths of stay appear to be the stronger influence. Financial constraints imposed by the Prospective Payment System (PPS) mandate inpatient rehabilitation facilities to reexamine resource utilization and organizational effectiveness. According to one study, charges at rehabilitation facilities are increasing an average of seven percent each year, but the length of stay is decreasing by approximately eight percent annually. (9) This translates to the fact that patients with chronic medical conditions may be leaving acute inpatient rehabilitation facilities before they are functionally ready, which results in increased reliance on community-based rather than hospital-based resources. Liss et al. (2) suggest that telecommunication-based interventions may be used efficiently and effectively for populations with chronic disability including those who do not have previous experience with the technologies. Rosen (10) points out that the individual can stay in his/her community without losing the expertise available in the larger hospitals, which would result in reduced travel expenses for the physician/therapist and patient; possible delivery

of a greater proportion of therapy by less expensive community providers with occasional teleconsultation by specialists; as well as a shift of the overhead of housing a patient from the service provider to the family.

Identification of stakeholders and champions

Stakeholders may be internal or external to the organization and are individuals, groups, or organizations with an interest in a given focus area. For the telerehabilitation program, the internal stakeholders included hospital administrators, clinicians/therapists, clinical support staff, and information technology specialists. External stakeholders were third party payers, case managers, referring physicians, patients, and their caregivers. Stakeholders were identified and their diverse interests defined, understood, and updated as the situation evolved. Recognizing and working with the underlying concerns, desires, and fears that motivate an individual are critical for their participation in the change process. Each stakeholder is unique and will have a different set of concerns and questions, which all need to be addressed. One frequently overlooked group of stakeholders is the knowledge-holders who possess critical skills to contribute to the problem-solving process. This group generally includes the researchers, rehabilitation engineers, clinical development specialists, and policy-makers. Knowledge-holders can play a key role of educating and facilitating discussion between stakeholders. Change acceptance starts with the stakeholders; and education of the stakeholders is vital. Change champions are stakeholders who buy into the new concept or idea, and play a pivotal role of championing the project.

The INTEGRIS telerehabilitation program was trademarked INTEGRIS TeleRehab™ for name-branding and focused on gaining support from the top, but building the program from the ground up. The program had both administrative and a clinical champions. The director of the telemedicine program was the administrative champion, educating the key administrative people about telemedicine program and services, thus creating administrative and executive buy-in. The administrative champion also communicated with the rural sites and the system support staff. The director of Clinical Development served as the clinical champion, focusing on educating and gaining support of therapists, clinicians, and rehabilitation patients and their caregivers. Both champions had the ability to think outside the box, and adopt alternate methodologies to accomplish their goals. A technical champion is also crucial to the success of a telerehabilitation program and should not be overlooked at any stage of program development.

Strategy

Strategy is a pattern in a stream of decisions, positioning an organization within its environment and resulting in the "behavior" of the organization. It is future-oriented and sets direction for the organization. Strategy ties the organization together with a common sense of purpose of shared values; enabling the organization to develop a clear concept, specific goals, and consistency in decision-making. Setting clear strategy goals is the most crucial component of any change. Strategies should align with the mission, vision, and values of the organization. Strategy should be *simple* as it is a template for decision making; *competitive* as it defines the product and services at which the organization will excel; *innovative* as it requires new perspectives from both outside and inside the organization; *responsive* as it defines the organization in terms of

stakeholders and the competition; *evolving* as it requires room for improvising; and *involving* as it should not be isolated to the top levels of the organization.

The vision of INTEGRIS Health is *to be the health care delivery system of choice, committed to caring service, quality outcomes and cost competitiveness.* Specific INTEGRIS Health goals for the next five years that directly relate to the INTEGRIS Rural Telemedicine Project include patient goals, physician goals, and community goals.

Patient goals include providing geographic accessibility, creating demonstrably better outcomes, and providing cost effective care. Physician goals include providing technology and sophisticated tools for care management. Community goals include providing care that exceeds stakeholder expectations, and improving the health status of the community.

INTEGRIS Rural Telemedicine Project concentrated on four areas in order to achieve these goals:

A	Solidify the growing reputation of INTEGRIS in the telerehabilitation field	
	1	By the formation of a Telerehabilitation Planning Group including a patient advocate,
	2	Through collaborations with other rehabilitation and academic centers in clinical applications and research,
	3	With publications and presentations at the state and national levels to government departments, healthcare associations and providers, and at related conferences.
B	Establish a market presence by	
	1	Proving efficacy, cost savings and improved accessibility through the pilot study,
	2	Marketing indirectly through articles in national publications and local newspaper as well as news reports on television,
	3	Direct marketing through brochures distributed to healthcare providers by the Oklahoma Healthcare Authority and contact with school districts, and
	4	Marketing directly to the patients and caregivers by working through special interest groups, such as the Brain Injury Association, and Rural Health Association.
C	Develop services based on the needs of the rural facilities	
	1	Need assessments based on Joint Commission for Accreditation of Healthcare Organizations (JCAHO) deficiencies
	2	Needs indicated by rural primary care physicians and other healthcare professionals
	3	Shortages as indicated by state statistics
	4	Needs indicated by government and community members

D	Promote Telemedicine on a state level	
	1	Work with the Governor's Telemedicine Advisory Council to promote telemedicine to third party payers, legislators, and general public
	2	Help build the Oklahoma State Website and INTEGRIS website, which includes projects and services available through INTEGRIS
	3	Work with the Department of Health and other state departments to promote a state-wide network of telemedicine providers.

Table 1: Rural Telemedicine Project Goals and Objectives

The primary reasons for misalignment of mission, vision and values are unclear strategic direction, lack of cohesion and open communication channels in the senior management team, leadership that is too top-down or lenient, ineffective vertical communication between management levels in the same department, lack of institution-wide coordination and integration, and lack of down-the-line leadership development and training. To prevent misalignment, most of the system goals are echoed by the individual hospital goals. The INTEGRIS telerehabilitation strategy is revisited annually and modified according to the current needs and circumstances.

Development of the TeleRehab™ Program at INTEGRIS Health

The foundation of the TeleRehab™ was established in 1999 when a speech teletherapy pilot study was initiated in an elementary public school in Hugo, Oklahoma. The administrator of the telemedicine program approached administrators at the Hugo Hospital to determine if there was a "need" for telemedicine and learned that the local school was unable to recruit a speech-language pathologist for students with disability. Schools are federally mandated to provide speech therapy services to the students; however, hiring a speech therapist is not only economically challenging for the schools but is often not feasible due to lack of therapist availability in the rural areas. This rural school was already using audio-visual equipment for distance learning, so school personnel were familiar and comfortable with the equipment.

Permission for a pre-pilot study was obtained from the school board, and eight students were provided speech therapy within the local rural hospital, which was already using telemedicine for emergency room visits. Speech teletherapy was conducted for four weeks, and the results, including complete cost analysis were presented to the Hugo school board. Based on these results, the school board approved therapy services via TeleRehab™ for one year.

Expansion of services to other schools followed the same pattern of demonstration of efficacy resulting in approval by the school board. Currently, our organization has contracts with four different rural school systems throughout Oklahoma and employees two full time equivalent speech teletherapists who conduct approximately 168 hours of direct service per month to students with both acquired and congenital disabilities.

Clinical and administrative champions should do their homework before venturing into an uncharted territory. Learning from the experience of other organizations is beneficial. This information can be obtained by web sites, trade journals, focus groups, phone calls, and site-visits. It is also helpful to find a mentoring organization of a similar nature providing telemedicine services. However, when INTEGRIS Health started its telerehabilitation program, there was very little telerehabilitation activity in the country. Since INTEGRIS was treading new terrains, it was decided to focus on one discreet area that would be less controversial and more likely to succeed. This area proved to be school-based speech therapy services. Once these services were successfully in place, the program proceeded to build on its success by adding other allied health disciplines and expanding the market base. The TeleRehab™ program has subsequently expanded to include physical therapy, occupational therapy, physiatry, vocational

rehabilitation, and psychology. The tool used for process development by INTEGRIS Health was PDCA, which follows an iterative cycle of planning the process improvement, doing process improvement, collecting data, and analyzing data (Figure 2). The PDCA model also forms the anchor for organizational learning and success; which is the innermost layer of the onion model and the desired end-point of all effort.

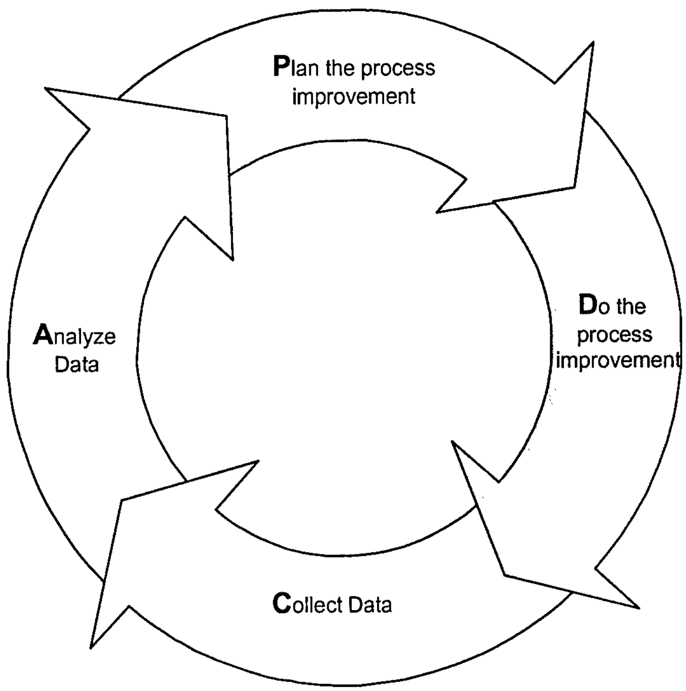

Figure 2
PDCA Model for Process Development

Services are currently offered to schools, third party payers (such as workman compensation and self-insured industries) as well as to the general public. The current TeleRehab™ network covers north-central, northeastern, southeastern, south-central, and western Oklahoma. (Figure 3) Services fall under one of the three categories:

- Direct patient intervention where the therapist either works directly with the patient or guides the remote therapist or caregiver.

- Mentoring with the patient present, which includes teaching management strategies, activity selection with grading, and handling training and development.
- Consultation where the patient is not present, which includes concepts and practice discussion, session analysis and feedback, and planning.

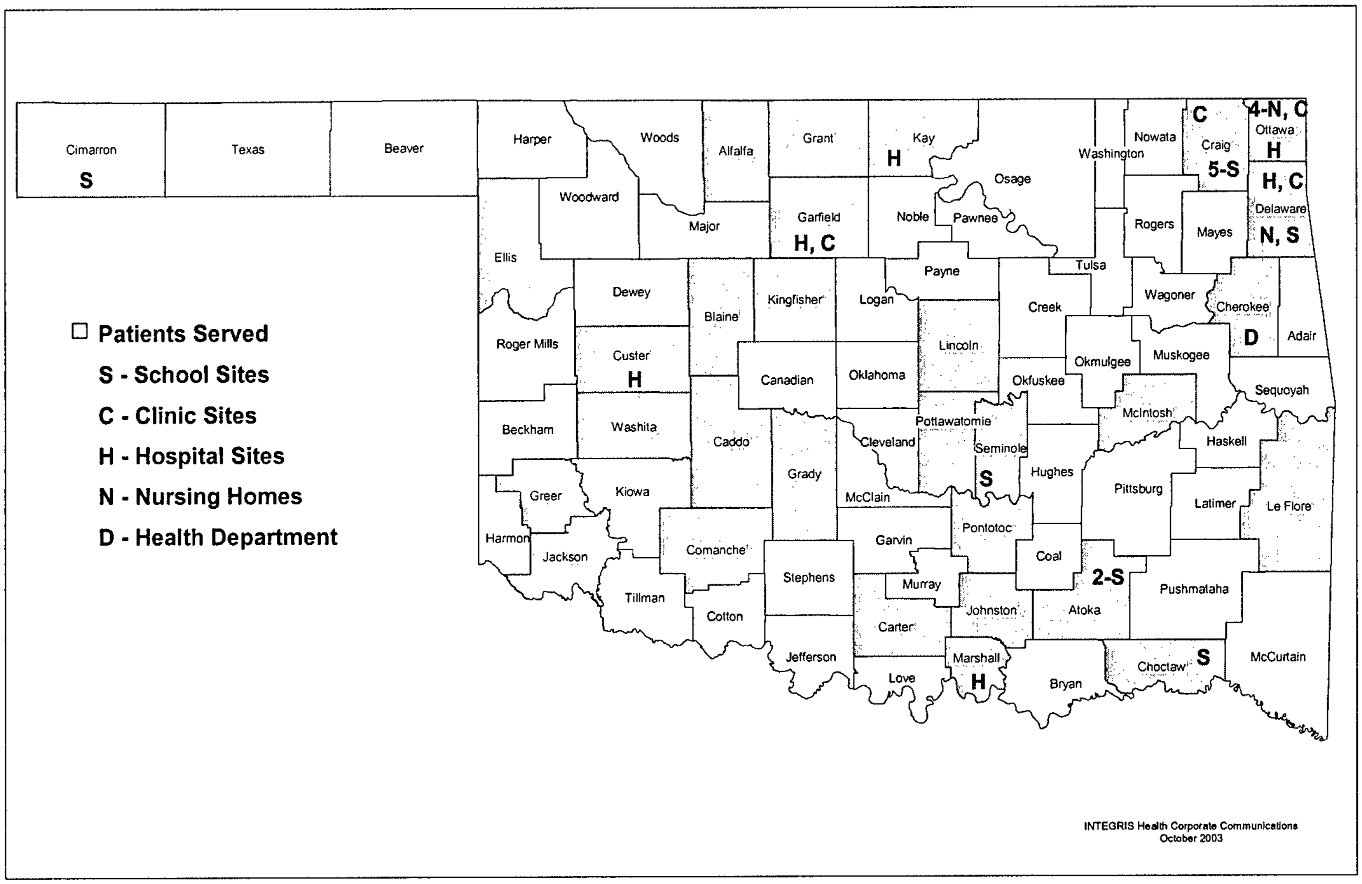

Figure 3: Coverage of INTEGRIS TeleRehab™ Network as of October 2003

Structure

Structure provides the building blocks for the program. Structure considerations center on such questions as: 1) Do all layers of the organization have the adequate information, resources, and

tools to support the innovative program; and 2) Does the organization have the structure in place to monitor quality, service, cost effectiveness, and team work. In order to have these questions answered, general structure component deals with:

- Information access and dissemination
- Physical plant layout
- Outline of functional departments and their integration and fit to other departments
- Centralization versus decentralization
- Equipment (automation/specialization)
- Human resource development such as recruitment and retention of staff, job role and function
- Financial structures including payment and distribution, cost containment and maintenance
- Policy development
- Competency development of staff

Business Model

The INTEGRIS TeleRehab™ business model is not static, but keeps on evolving as technology, consumer and clinician acceptance, and reimbursement components change. The business model defines the scope, goals, competitive advantage, value constellation, and value chain of the business unit. At INTEGRIS, there is a separate cost center for telemedicine with a dedicated director and a telemedicine coordinator. Establishing TeleRehab™ as a separate cost center facilitates management of the program. However, this should be done once the program is well planned and implemented. Making the program autonomous allows easier financial tracking.

Having TeleRehab™ as a separate business unit also addresses the ambiguity of program ownership secondary to diverse stakeholders.

Both the grant-based telehealth projects, and the start-up telehealth companies should have a clear and focused business plan. The content of the plan varies based on the specific program; however, it generally incorporates information about the company profile; principal services being offered; target customers; projected sales or consultations; partnerships with other organizations if any, overview of needs assessment, cost profiles, contractual agreements if any, quality measures; risk management; competition; sales and marketing techniques; company management; financial management; and research and development (R&D). (13)

Organizational Commitment

Telehealth implementation and sustainability require interdepartmental support and resources. Organizational commitment is required at all stages of conception, implementation, and management of the program. Education of the executives and the stakeholders is paramount for continued organizational commitment. The telehealth program at INTEGRIS Health has mixed executive buy-in. The program was accepted at its inception largely because of the funds coming from the HRSA grant. However, the program is increasingly gaining support. After five years of initiation of the program, telehealth has been included as part of INTEGRIS Health strategic plan at the organizational level. TeleRehab™ has also transitioned from being a project to a program, and is now considered part of the normal INTEGRIS Health business, instead of being an experimental R&D model.

Economic Model

Sustainability does not always equate to profitability in the initial phase of telehealth implementation; however, a stream of revenue and profit are essential for long-term sustenance of the program. Grant funding is helpful as seed money to help with one-time costs associated with the initial set-up. A significant number of telehealth interventions are not reimbursed. Currently, Center for Medicare and Medicaid Services (CMS), the primary federal funding agency for healthcare, requires face-to-face evaluation for reimbursement, except for image applications such as radiology. A number of demonstration grants are currently underway to establish the efficacy of telehealth as an alternative healthcare delivery model, and make a case for reimbursement initiatives and legislature. Long-term viability depends on contracts and third-party reimbursements. Diversifying sources of revenue; with a combination of stable but marginal revenue sources, with a revenue source with an intermittent but high return on investment is a safe strategy.

Contracts

Contracts are often associated with agencies or organizations that require interventions for a number of people over an extended period of time, such as schools or prisons. Contracts can be based on a flat fee model, or an hourly rate. The contracts for school therapy program at INTEGRIS Health underwent four stages of evolution. The first stage comprised of a flat fee, regardless of the number of hours used or the number of students seen. At one point, when extensive technology problems precluded service delivery for six weeks, billing adjustments had to be made. The next year, the contract was modified to bill based on the number of hours used. However, this model had the negative effect of school teachers canceling speech teletherapy session at will, which resulted in unproductive time for the speech teletherapist that could have

been spent with other patients. A hybrid contract model was introduced in the third year. This required reimbursement of half of the anticipated sessions, whether they were used or not. The hybrid contract reduced the number of cancellations, thus increasing compliance and benefiting both the students and the teletherapy program. The final modification to the contract was a slight increase in charge to help pay for the extra time for paperwork required for schools to receive Medicaid reimbursement for some students. This has been a popular feature of the INTEGRIS speech teletherapy program as it helps the schools receive funds for special education that would be otherwise unavailable to them. Clear outline for the service care delivery, agreements on quality standards, and regulatory requirements should be addressed in the contract. Table 1 provides a template for cost analysis of telehealth as a substitute for face-to-face visits, along with estimated value for each variable(14).

No.	Questions Concerning Variable Costs	Estimated Value
1	How often is the telehealth system a successful substitute for a face-to-face visit?	90%
2	What %age of patients would drive to a specialist if TM was not available?	70%
3	How many miles will patients drive (round trip) to the telehealth facility?	16
4	What is the cost of transportation per mile ?	$0.31
5	How many hours of a patient's time will a telehealth consultation take?	1.14
6	What value do the employers and patients' place on their time?	$13.44
7	What is the average payment to physicians per telehealth consultation?	$65
8	What is the hourly cost of telehealth broadcasts?	$35
9	How many hours of technical support are needed for each hour of consultation?	1
10	What is the average number of consultations per hour?	4
11	What is the hourly cost of technical personnel who operate the system?	$30
12	What is the hourly cost of having a nurse at the spoke site?	$20
13	How many minutes of nurses time will be used for each consult?	20
14	What is the cost of the spoke's supplies used for each consult?	$8
15	How much additional hub overhead is generated for each consult due to billing etc?	$2
16	How much spoke overhead is generated for each consult for record keeping etc?	$5

17	What is the average total fee paid to a physician's clinic for a face-to-face consultation?	$65
18	How many hours will a visit for a face-to-face consultation take?	7.63
19	How many miles (round trip) will patients drive to see a specialist?	304
		Example
	Questions Concerning Fixed Costs	
20	What is the cost of equipment and improvements?	$144,128
21	What is the average life of the equipment and improvements?	8
22	What is the organization's cost of capital?	5%
	Implied annual amortization of debt used to purchase fixed assets	$21,238
23	What is the annual cost of the hub's administrator?	$27,000
24	How many fixed hours of technical support per week are needed to maintain the system?	16
25	How many square feet of hub office space is needed?	500
26	What is the value of the hub's office space per foot?	$11
27	How many square feet of office space is needed at the spoke?	350
28	What is the spoke's cost of office space per square foot?	$11
29	What is the annual cost of the spoke's administrator?	$4,000
30	How many hours of administrative assistant time will be needed per week?	10
31	What is the hourly cost of administrative assistant time?	$11.70
32	How much will be spent on training and travel?	$2,000
33	What is the amount of hub overhead for phones, system overhead etc.?	$5,000
34	What is the amount of spoke overhead for phones, system overhead etc.?	$2,500
35	What are the hub sites annual fixed telecommunications costs?	$5,724
36	What are the spoke site's annual fixed telecommunications costs?	$4,728
37	How many hours of line time will be needed for telehealth administration?	24
38	What percentage of the overhead will be allocated to consults?	50%
		Estimated Cost
	Comparable Face-to-face Visit Cost	**$183.34**
	Telehealth Visit Cost	**$144.34**
	Savings per TM Visit	**$39.01**
	Total Fixed Costs	**$113,046**
	Break Even Point (Telehealth Consults)	**1,449**

Table 2: Template for Cost Analysis of Telehealth and Face-to-Face Visits with Estimated Values

Fee for Service

Reimbursement through the third party payers is the largest source of revenue for telehealth programs. Rules governing reimbursement for telehealth services vary from state to state and the

type of service provided. Under current Medicare regulations, only physician and psychology telehealth services are reimbursed. Beginning in 1999, Congress mandated CMS to pay for telehealth services to patients in HPSA. Efforts have also been underway at the state level pushing reimbursements for telehealth consultations. California, Oklahoma, and Texas have now eliminated face-to-face evaluation as a requisite for reimbursement. Reimbursements are limited to the interventions at the remote clinic settings, and do not include therapy provided at the patient's residence. Third party payers are now reimbursing telehealth services in several states, and about 12 states have partial Medicaid reimbursements. (15) At INTEGRIS, therapists work with the administrative sections of the organization for billing and compliance purposes. Current Procedural Terminology (CPT) codes, documented therapy procedures, service units, and costs for TeleRehab™ sessions have been developed and are documented for reimbursement purposes. TeleRehab™ therapists have given numerous presentations for state legislature and CMS to educate and build a case for reimbursement for telerehabilitation based interventions.

Infrastructure and Equipment

Infrastructure and equipment fall under the 'technical innovation' layer of the onion model. However, it is imperative to base the decisions regarding the infrastructure in context of other layers such as 'cultural and institutional context', 'actors, network, and alliance', and 'mental models and clinical perspective'. Irrespective of how advanced the technology is, it is ineffective if not adequately utilized.

Setup costs include the costs of the infrastructure including audio-visual equipment, lease lines, phone bills, hiring of new personnel if needed, marketing, and training costs. Infrastructure cost

associated with the implementation of a telehealth program can be significant. Infrastructure should be adapted to the technological needs of the application, cost, comfort level of the users, and availability of resources in the remote areas. If targeting rural populations, it is advisable not to invest in the computer or Internet based platform since the majority of rural population is limited in their access and knowledge of computers. Simplicity of installation is preferred. Universal Access Fund provision of the 1996 Telecommunications Deregulation Bill provides funds to subsidize certain telecommunication services to rural, non-profit healthcare providers. (16) INTEGRIS telehealth system interfaces with OneNet, the Oklahoma Telecommunications backbone, which also links Oklahoma public schools and several hospitals. Connections have also been made to various educational and hospital networks in other state for conferencing and research training.

Bandwidth consideration is an important aspect of designing the infrastructure. When using videophones, there is a great disparity in the quality of video. This is important when looking at fine motor movements as in speech therapy. There is also individual tolerance level among therapists as to the level of clarity and smoothness of motion that will be acceptable. The therapists are therefore involved in equipment selection. Bandwidth is directly proportional to the data carrying capacity and the cost. INTEGRIS Health Rural Telehealth project began with a focus on high-end technology. H.320 video conferencing systems with T1 lines were used. While the first pilot study was successful, it identified challenges associated with the use of this technology. Patients had to travel to the nearest site where this equipment was available, although this was still considerably less than the distance to a specialty rehabilitation outpatient site. This was a highly reliable technology utilizing a transfer rate of 384 kbps at 30 frames per

second. The cost of equipment and the line lease were the major limiting factors. Travel by patients was not always feasible, so the focus shifted to exploration of technology options that could be utilized at home.

Low technology equipment was experimented in 2000, and rapidly gained favor by metro and rural healthcare providers because of increased convenience, ease of scheduling, and increased application potentials. "Plain Old Telephone System" (POTS) was used for the telerehabilitation connections. H.324 desktop videophones were utilized for these interventions. Desktop videophones are easy to install, and require the user to just plug-in the videophone into any ordinary phone jack. Operation involves dialing a telephone to establish an audio connection and then pushing a button for video. The unit provides real time video communication with adequate quality video and audio connection. The maximum transfer rate is 33.6 kbps with video streaming at 18-22 frames per second and costs $1,600 to $2,500 depending on the model and capabilities. Home-use equipment should be compatible with the phone systems in the area. A complete list of different camera equipment including the recommended specifications, benefits, drawbacks, and approximate cost for each is available at http://telehealth.hrsa.gov.

Purchase and implementation of the system does not alone constitute the infrastructure. Factors such as network management responsibility, equipment insurance, and room design should be taken into consideration. Room design including lighting, sound, and video placement is important. Light should be on the patient, and not behind them. Half of the teletherapy sessions conducted by INTEGRIS have been in the residential settings. The camera should face away from the windows and ceiling lights. Background movements such as fans, and any fish tanks in

the room, should be avoided as they result in excessive disconnects. Backgrounds and paints should be flat, and preferably monochromic.

Processes

Processes complement and frequently overlap the program structures. Processes for establishing a telehealth program should focus on protocols and service delivery, training, outcome measures, and regular evaluation and feedback.

Protocols

INTEGRIS TeleRehab™ program has developed protocols for referrals, screening, admission, evaluation, recertification, discharge, billing, coding, documentation, and use of data for research purposes. This has been a constant learning process, which has been developed over time from experiences with the program. The protocols have followed refinement and written documentation of the workflow. A team of managers, therapists, and other support staff meet biweekly to refine strategy, and discuss cases, coding and billing issues.

Training

The majority of implementation and operational problems associated with telehealth can be traced to inadequate training. Training modules should be prepared for telehealth coordinators, clinicians, and support staff. The primary focus of training is on therapist comfort and familiarization with the new technology including operation, installation, and troubleshooting of the equipment. New verbal skills including unambiguous description and instruction are necessary to compensate for the lack of hands-on demonstration or examination. Training also

covers cognitive knowledge, physical examination skills, ability to communicate with the patients through audio-visual means, and suitable documentation of a telehealth encounter. Education of target healthcare providers and consumers is accomplished via direct demonstrations, continuing medical education (CME) or continuing education unit (CEU) courses, and brochures. Training can be imparted through a combination of direct demonstration, instructional tapes, or written materials. It is advisable to develop a formal training program over time that includes skills assessment and trainee evaluation.

Documentation and Outcomes Measures

Anecdotal evidence is not sufficient to scientifically establish the efficacy of a program. Collection and analysis of outcomes measures helps in establishing the efficacy of the program, and aids legislators in reimbursement issues. Outcomes measures also highlight any inherent deficiencies in the program and provide a framework for further program improvement and refinement. Outcomes measures collected for TeleRehab™ focus on clinical outcomes, subjective and objective quality of life, customer satisfaction, and research opportunities. Cost analysis outcomes include revenue dollars, frequency of hospitalizations, number of consultations, travel costs saved; and value added to the institution's mix of services. Technical outcomes include mean time between failures, connection and display problems, and rate of usage. INTEGRIS Health is also investing in developing a database for outcomes measures for telerehabilitation. A prototype is currently being developed in Microsoft Access that will be later upgraded to Structured Query Language (SQL) with a Java front end.

People

Effective management of people during a change process is often the key to a successful change initiative. People can be categorized as innovators, early adopters, or late adopters. Innovators are the risk takers who can cope with a high degree of uncertainty during adoption of a new innovation, and are highly suitable as champions for a new project. Early adopters are the target population for education and conversion during a change process. The late adopters wait for the change to be a proven concept before adopting it. (11) People involved in the TeleRehab™ program are the administrators, therapists/clinicians, information technology specialists, researchers, patients, and their caregivers. These correspond to the "actors" of the fourth layer of the onion model. Education and user involvement at all levels of the change process are critical. Individuals have difficulty sustaining new behaviors in an old environment, so the goal should be to change the environment as well. The environment should expect, encourage, and support personal accountability, diversity, open expression, conflict as a source of creative tension and growth, participation at all levels, and caring and respect for all members of the organization.

Therapists

Therapist acceptance and utilization are the cornerstones of a successful telerehabilitation program. Experienced interdisciplinary teletherapists identified attributes important for a productive and meaningful teletherapy intervention or encounter. Attributes of successful teletherapists include flexibility, professional maturity, creativity, motivation, clinical competence, sense of humor, good interpersonal skills, person first philosophy, intuition, tenacity, excellent problem solving, empathy, and good communication skills. Unfamiliarity with technology and an inability to touch the patient for examination are potential sources of therapist

dissatisfaction. Therapist resistance can be overcome by proper education and training. Proper orientation of the new teletherapist is paramount. A TeleRehab™ staff member is usually present during the first session to assist with any questions or problems with the equipment. Motivation in healthcare goes beyond monetary incentives. Quality of care and patient satisfaction reinforce clinician satisfaction. Technology is only a 'tool' to provide service; the people involved determine the success of the program.

Customers/Consumers

Patients and their caregivers are an important and often overlooked component of a telerehabilitation program. Certain inclusion criteria have been identified for patients who participate in teletherapy. TeleRehab™ patients have generally participated in successful inpatient hospitalization or outpatient service. Patients should be medically stable, and a support person is generally required if the patient requires supervision for physical and/or cognitive impairments. The patient's support person is trained about the operation and basic troubleshooting of the audio-visual equipment being used. In addition, this support person must be able to comprehend audio-visual instructions, should be physically able to help with therapy, and should be compassionate towards the patient. Whenever possible, the initial evaluation of the patient is done face-to-face in the presence of their caregiver, which facilitates the subsequent teletherapy sessions. Involvement of distant health care providers in the initial patient encounter via TeleRehab™ is beneficial.

Remote therapists

Development of collaborative efforts with the rural therapists is of significant importance. Despite generalization, each rural area has a unique culture and unspoken rules. Having a local person as a guide or mediator often facilitates gaining trust and overcoming resistance or hesitancy on the part of the users to try an alternative healthcare delivery model. Territorial issues sometimes arise when partnering with rural therapists. Rural therapists are generally independent due to lack of peer support. Cultivation of a symbiotic relationship requires patience and education on the part of teletherapists.

Dealing with Resistance

Resistance to change is a common phenomenon that accompanies a change initiative. Resistance can be deliberate or subconscious, and it typically interferes with the successful implementation of a change initiative. Resistance can be encountered at all levels of the organization. The reasons for resistance can be economical, psychological, social, intellectual, prior unfavorable experiences, organizational, or operational. (12) Resistance and other human factors constitute the 'mental models with clinical perspective' layer of the onion model. User involvement and education facilitates the change process. Honest and open communication is key to dealing with the user's concerns.

Results

As of October 2003, a total of 3397 TeleRehab^{TM} sessions were conducted by INTEGRIS in a variety of settings.

Table 3: Patient Interventions by Discipline		
Discipline	**# Consults**	**Hours**
Audio/Verbal Therapy	82	77
Neuropsych	23	19
Occupational Therapy	39	21
Physiatry	126	32
Physical Therapy	473	397
Speech Language Pathology	2651	1619
Vocational Rehabilitation	3	3
Total	**3,397**	**2,165**

User satisfaction

Satisfaction surveys are routinely given to providers, patients, and caregivers. Patient satisfaction ratings have generally been positive. Nine out of ten negative comments were related to technology issues. Analog lines are affected by weather conditions, especially wind, which can be a considerable problem in Oklahoma. For the school-based speech teletherapy program, students were slightly less satisfied than the patients (Figure 4), which can be attributed to the fact that they were not given an option to choose between TeleRehab^{TM} and face-to-face interventions. The relationship between the student and the therapist also influenced the

satisfaction rating. The satisfaction of patients was also affected by increased accessibility and travel costs saving.

Among the therapists, speech therapists rated telerehabilitation lower than other allied health disciplines (Figure 5). These lower ratings have been traced to technology problems during the early phases of the school teletherapy program. The technology issues have subsequently been addressed resulting in higher speech therapy ratings. TeleRehab™ forces therapists to interact with patients verbally rather than through tactile means, which can be less satisfactory for some therapists during the initial period.

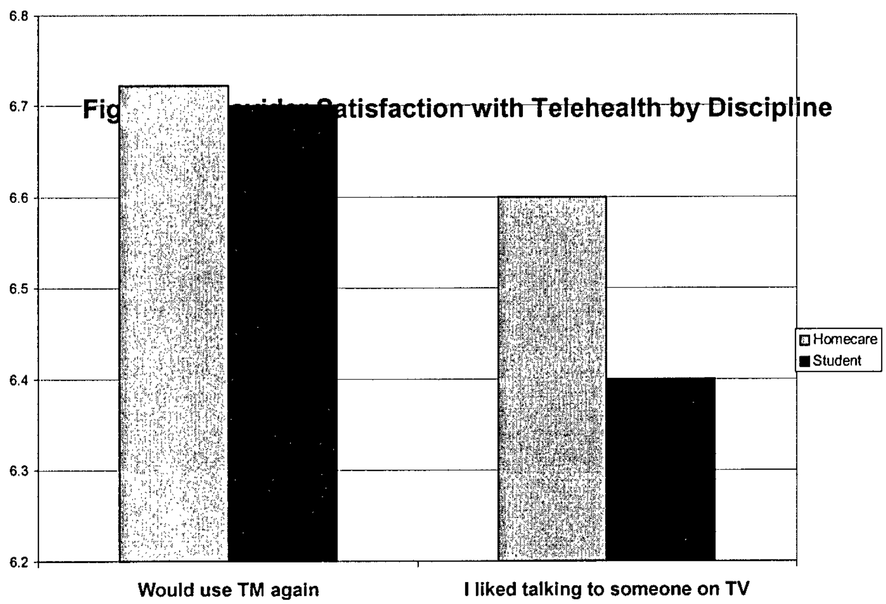

Figure 4: Patient Satisfaction with Telemedicine
1= Dislike 7= like very much

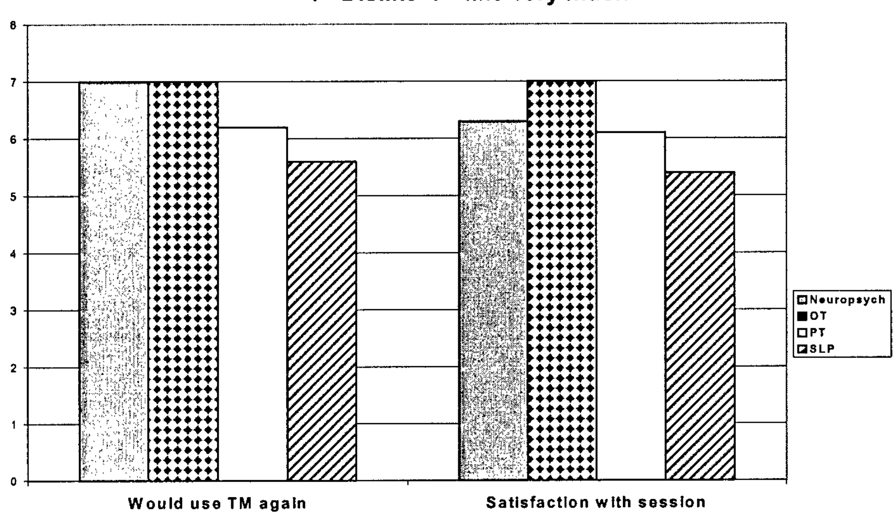

Figure 5: Provider Satisfaction with Telemedicine by Discipline

1 = unsatisfied   7 = very satisfied

Constant user feedback and evaluation are important for reassessing, rethinking, redesigning, or reengineering the program. The TeleRehab™ program implementation is a constant change process. Feedback and evaluation are crucial during the initial phases. The business plan and the workflow processes should be reassessed periodically based on the feedback.

Cost savings

Cost savings can be direct (reduced provider travel) or indirect (reduced length of stay or adverted emergency department admissions because of early intervention). If the program is considered a cost of doing business because of the value it adds to the institution, this should be documented. TeleRehab™ is a resource to other departments to help increase their revenue or decrease costs. Revenue is a combination of grant funds, reimbursements, and educational programs. Value of telehealth should also be assessed in terms of visibility and stability it provides to the organization. Savings during a six-month period included:

- Home care miles saved: 13,874 ($49,946 saved at 0.36/mile)
- Home care productivity saved: 231 hours ($4,158 saved at $18/hr)
- Hospital readmissions reported as averted: ($10,000 saved: 2 at $5,000/admit)
- Provider (not home health) miles saved: 36,912 ($13,288 saved at 0.36/mile)
- Provider productivity saved: 615.20 hours ($14,760 saved at $24/hr)

Total savings in travel, productivity, and adverted non-pay hospital admissions: $92,152

Cost Savings to other departments

Clinical services (home health /hospice/wound care/averted no-pay) –	$266,500
Telecommunications (Network line lease reimbursement)	$200,000
Administrative travel	$361,527
	$828,027

For patients, savings in terms of travel costs were $64,366 (178,794 miles at the rate of $ 0.36/mile). Average mileage to provider was 36 miles, 71 percent of the patients did not have their own transportation, and 25 percent would not have received help without TeleRehab™.

Conclusion

Adequate change management is a necessity in today's dynamic healthcare environment. Change efforts fail by trying to short cut the steps in the organizational change process. Strategy, people, structure, and customers are the five critical components of change.

Strategy should always be finalized first as it lays the groundwork and outline for the rest of the change process. **Lessons Learned:** 1) When implementing a new initiative, people frequently make the mistake of changing the structure first as it is the most visible of the change elements. However, without adequate groundwork, purely structural change is not successful or sustainable; and 2) Having frequent milestones with short timelines keep the people focused, however, the timelines should be realistic and practical. TeleRehab™ should be viewed as a support service with rehabilitation as the primary or actual service, and TeleRehab™ an extension of the traditional rehabilitation services.

Structure and *processes* are the building blocks of the long-term change process, and they frequently overlap. A sustainable change is a function of attention to the global picture, stakeholder buy-in, skills, managed risks, and continued action. **Lesson Learned:** 1) Program strategy, personnel, structure, and processes should be revisited regularly, with changes made as needed; 2) While contracting for services, it is important to promise only what can be delivered. The program should preferably start with a targeted niche area, and then build on that success. Diversifying the services offered is an important component; and 3) Continuous feedback and evaluation resulting in continuous process improvement is essential. The new change effort must be anchored in the culture and process of the organization, only then will it result in a long-term successful change implementation.

People are critical to the adoption of a change management process. The change management process is deeply inter-related to the other components or layers of the organizational design as outlined in the onion model. A new change initiative should always start with the need assessment for change. **Lessons Learned:** 1) Identification and involvement of stakeholders are important at all points of the change process and during the maintenance phase; 2) Change advocates are the keystones of successful change initiatives and majority of change failures can be traced to human factors such as lack of risk-taking ability or perseverance; and 3) Education and user training are essential for the users to be comfortable with the change process.

The *customer* (consumer) is the core of traditional or innovative health care business. So it is only fitting to conclude our chapter with the customer component. Consumers are assuming a much more proactive role in the maintenance of their healthcare and have become equal

stakeholders with healthcare professionals. **Lessons Learned**: It is the belief of these authors that the end-users of innovative telehealth programs such as TeleRehab™ are the individuals with chronic health problems and resulting disabilities. Decisions about their healthcare are made mutually, rather than by the more traditional medical model in which the physician dominated these interactions. This trend will continue to advance as consumers educate themselves further and assume more active roles, acting in collaboration with their healthcare providers to receive alternative services beyond the traditional medical model.

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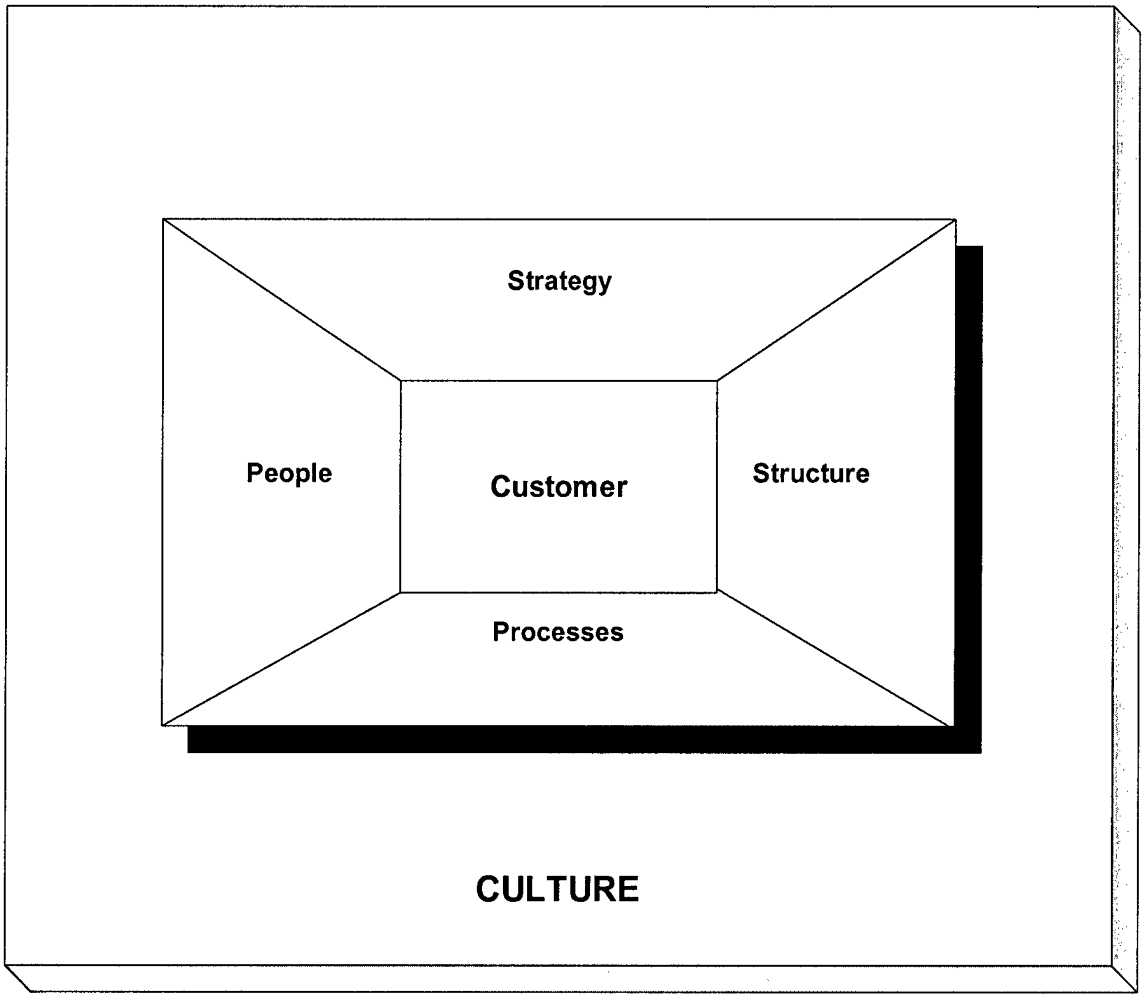


FIGURE 1
Interrelationship between Components of Change and Culture

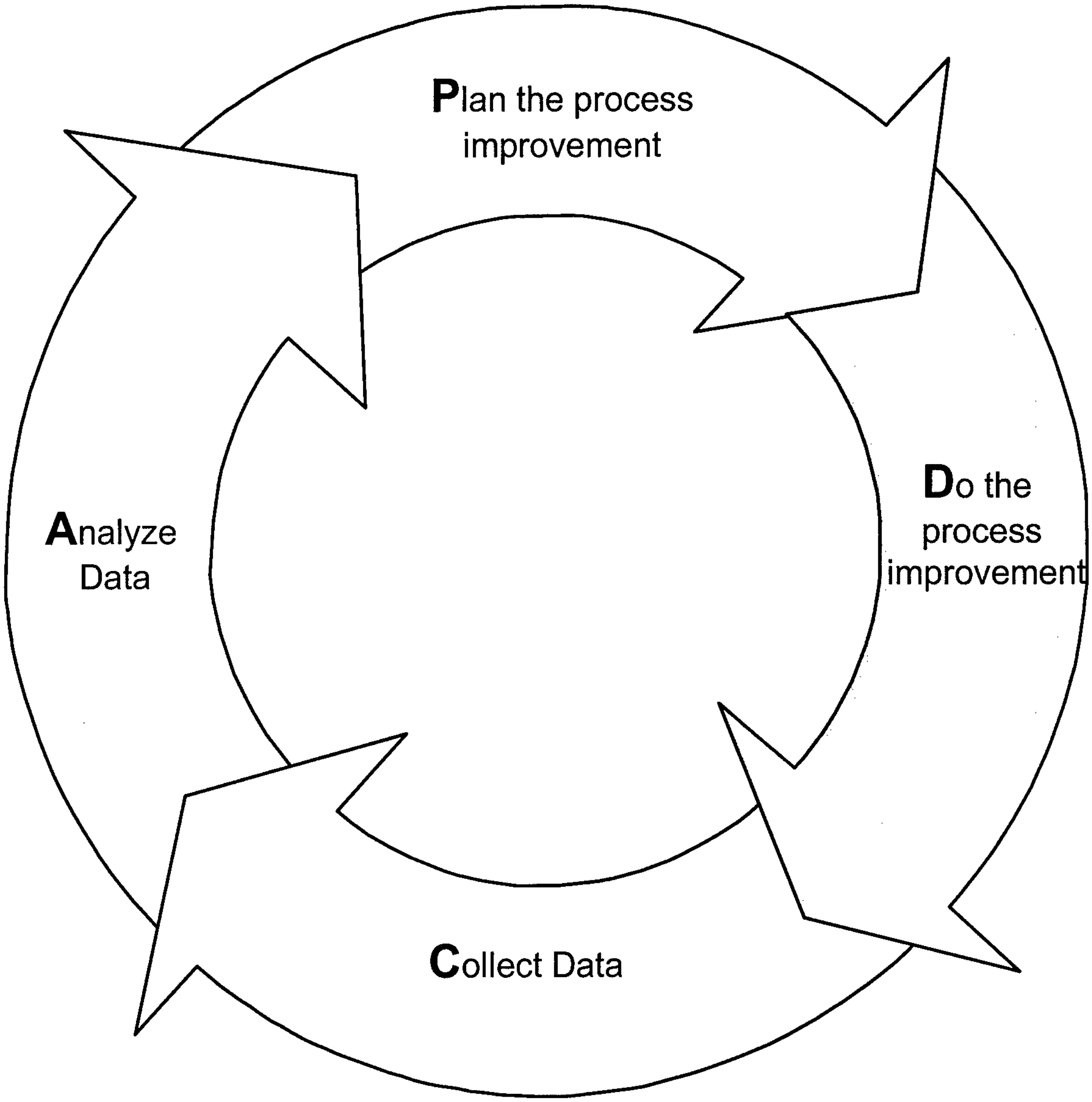
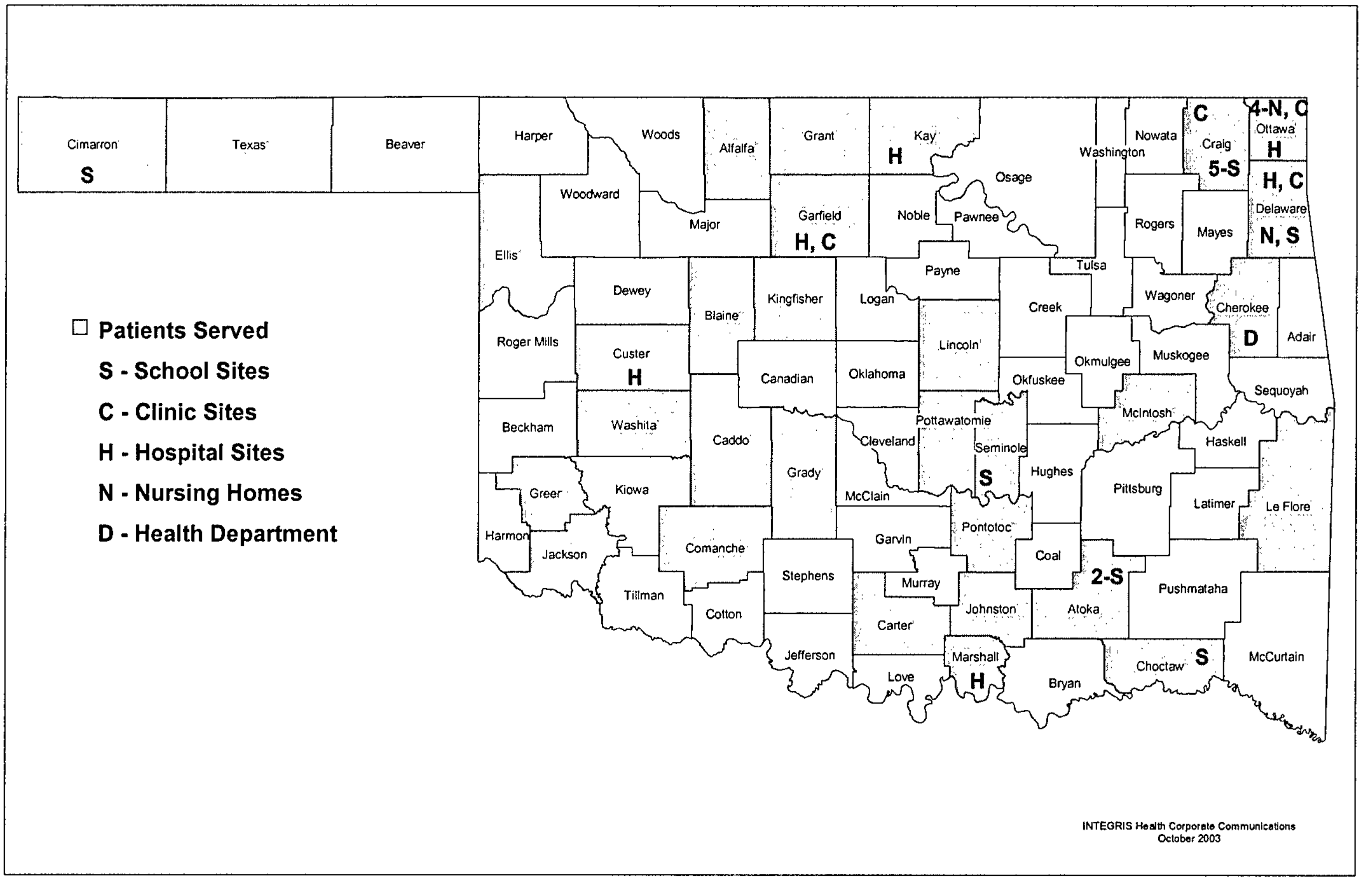


Figure 2
PDCA Model for Process Development



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□ Patients Served
S - School Sites
C - Clinic Sites
H - Hospital Sites
N - Nursing Homes
D - Health Department
INTEGRIS Health Corporate Communications
October 2003

Figure 3

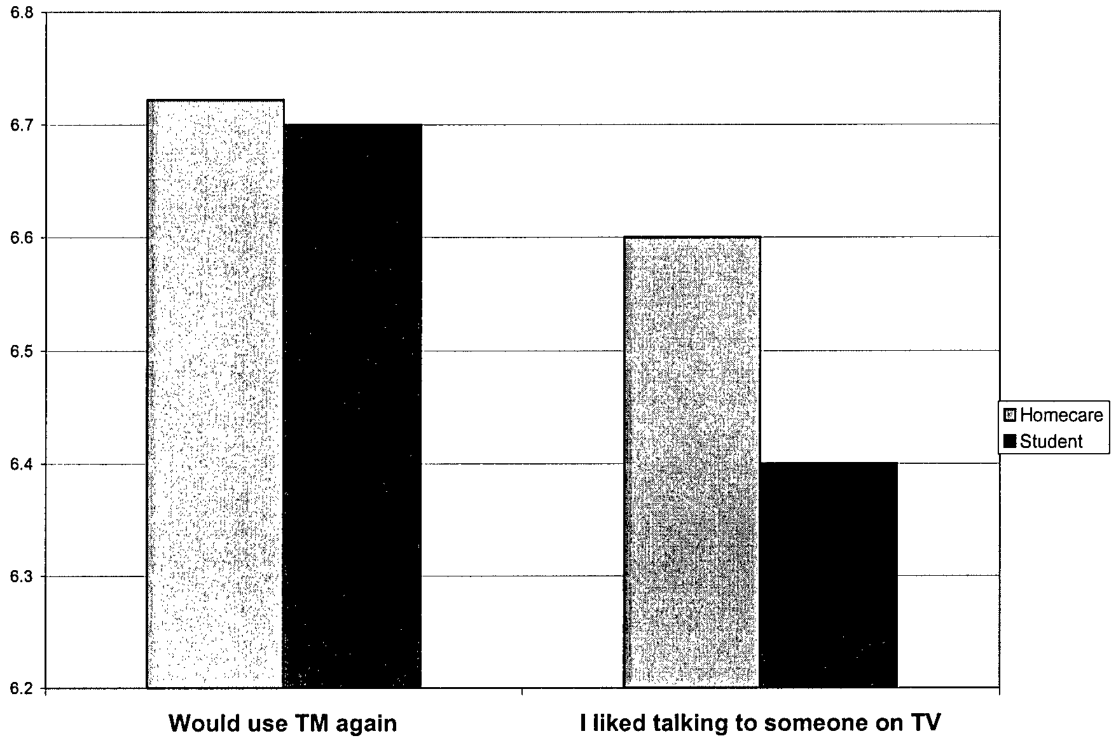

Figure 4: Patient Satisfaction with Telemedicine
1= Dislike 7= like very much

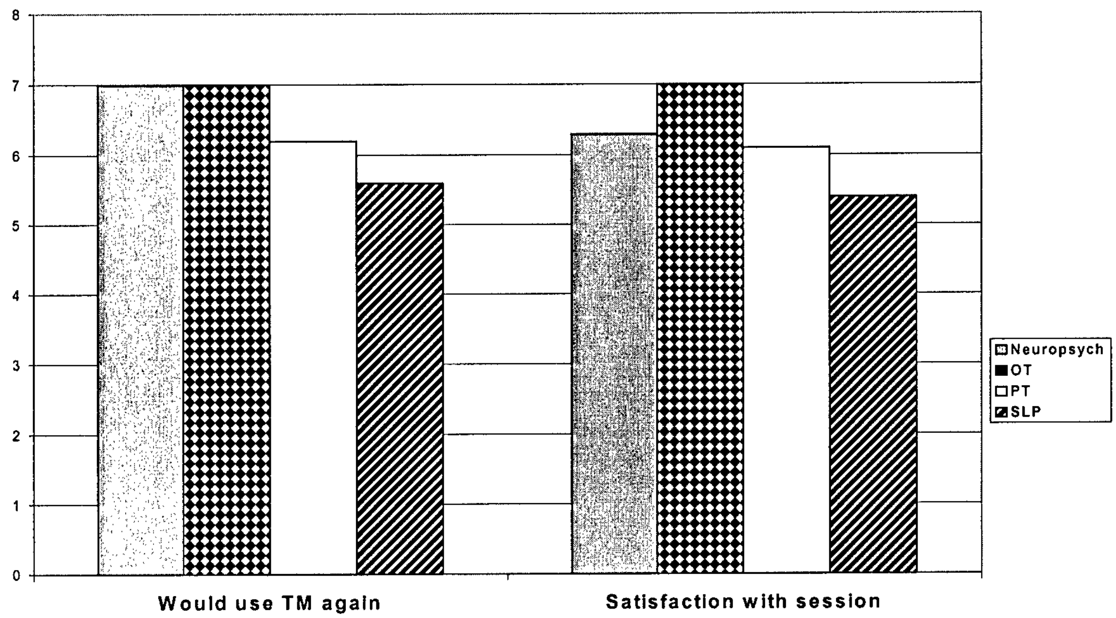

Figure 5: Provider Satisfaction with Telemedicine by Discipline
1= unsatisfied 7=very satisfied

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Organizational Innovation: The Influence of Individual, Organizational, and Contextual Factors on Hospital Adoption of Technological and Administrative Innovations[1]

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Bain and Company

Individual, organizational, and contextual variables were found to be much better predictors of hospital adoption of technological innovations than of administrative innovations. The two different types of innovation were found to be influenced by different variables. Organizational level variables, size in particular, were clearly the best predictors of both types of innovation.

The general topic of adoption of innovation has inspired voluminous research aimed at explaining why one organization is more likely than another to adopt an innovation. Gordon, Kimberly, and MacEachron (1975), for example, noted that their review of the literature bearing on organizational innovation yielded more than 2,000 items, and Kelly and Kranzberg (1978) found more than 4,000 items in their analysis of research on technological innovation. Certainly there has been no lack of attention to the issue, and a variety of economic, political, psychological, sociological, and managerial perspectives has been brought to bear.

Despite—or perhaps because of—the involvement of a diverse group of researchers, results at the empirical level often are noncomparable and occasionally contradictory. At this point, the literature on innovation consists primarily of a number of relatively discrete empirical generalizations

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and hypotheses. Several authors with a variety of disciplinary backgrounds have attempted to summarize and synthesize the research in this area (Brewer, 1980; Kelly & Kranzberg, 1978; Kimberly, 1981; Nelson & Winter, 1977; Rogers & Shoemaker, 1971; Utterback, 1974; Zaltman, Duncan, & Holbek, 1973). Generally, they agree that although an impressive amount of empirical research has been carried out, much remains to be learned about the conditions for and consequences of innovation.

CONCEPTUAL OVERVIEW

Of interest here is innovation in the context of organizations. Three basic issues in previous work helped to frame the research reported in this paper. First, researchers have tended to focus on a single innovation or single class of innovations in their studies, thus raising the question of generalizability. Within a given organization, such as an automotive assembly plant, for example, is the adoption of new production technologies, new scheduling practices, and new training programs influenced by similar or different variables or classes of variables? Little is known about how much influence, if any, variability in type of innovation will have on adoption or whether different variables may have different explanatory roles depending on the type of innovation in question. This issue has been raised by Downs and Mohr (1976).

The second basic issue is related to the nature of the studies. Many studies—perhaps most—of innovation are either case studies or are based on sample sizes so small as to preclude the possibility of the application of multivariate analytic techniques. This is not to deny the central importance of case studies as sources of insight and testable hypotheses. Rather it is to indicate that systematic quantitative comparative analysis of adoption behavior focused on the relative significance of different classes of variables requires larger samples than traditionally have been used.

The third basic issue is that, at the very least, the literature suggests that organizational adoption is influenced by the characteristics of individual people—usually organizational leaders; by characteristics of the organization itself; and by characteristics of the context in which it operates and out of which it emerged. At the most general level, it can be argued that a number of variables within each of these three categories have been found empirically to be related to adoption behavior. There is little in the way of evidence, however, to suggest (a) which variables within the classes of factors are most important (in the sense of explaining variability in adoption behavior), (b) the relative explanatory power of each of the three classes, or (c) whether the relative importance of the variables—or the classes—may depend on the type of innovation under consideration. The literature leads one to believe that all three classes play a role, but it provides little evidence on primacy.

Those studies that have been comparative in nature have tended not to include all three classes of variables noted above. For example, the work

of Hage and Aiken (1967) focused only on the relationship between organizational variables and innovation. The later work of Hage and Dewar (1973) focused on both individual and organizational variables and is particularly interesting because it underlines the importance of elite values in the adoption process and suggests that they may be more important determinants of adoption behavior than are organizational characteristics. One is not able, however, to estimate the importance of environmental factors from their study. The work of Baldridge and Burnham (1975) did include a limited number of variables from all three levels, but it clearly is an exception.

This paper addresses each of these three major issues. In brief, the intent was to examine the combined effects of individual, organizational, and contextual variables on organizational adoption of two types of innovation—one type directly related to the organization's core technology and the other related to administrative concerns—across a large number of organizations with the objective of moving toward a more comprehensive treatment of organizational innovation than heretofore has been found in the literature. No effort was made at the outset to develop *a* theory of organizational adoption of innovation and test it empirically. Rather, the strategy was to develop a number of bivariate hypotheses for variables that had been found in previous research to be significantly related to innovation adoption, and then to examine these posited relationships in a multivariate framework with two different types of innovation as dependent variables. This strategy was thus informed by previous research, was deliberately designed to include individual, organizational, and contextual factors, and was intended to capitalize on the advantages of comparative research. It thus was neither purely deductive nor purely inductive, the primary interest being to develop a more comprehensive set of analyses of innovation adoption than had been previously available in the literature.

DESIGN OF THE RESEARCH

One way to move toward a general understanding of innovation adoption is through intensive analysis in one particular sector of the economy. Although the applicability of findings in one sector to those in another is clearly problematic, concentration of the research focus can help to identify and isolate factors that clarify the nature of the phenomenon in that sector and, at the very least, can be helpful in suggesting hypotheses that may be generalizable beyond that sector and tested in others. The research reported in this paper concentrates on the health sector and attempts to identify the relative contribution of a number of factors to an explanation of observed variability in adoption of both technological and administrative innovations by hospitals. Although hospitals certainly are not the only potential adopters of innovations in the health sector, they are major consumers of innovations in the health care arena.

Both technological and administrative innovations are included in the research. Innovations in medical (or, in more general terms, production process) technology are directly related to the diagnosis and treatment of disease, which together constitute the basic work activity or mission of the hospital. Administrative innovations, which in this study all involve the adoption of electronic data processing for a variety of internal information storage, retrieval, and analytical purposes, are only indirectly related to the basic work activity of the hospital and are more immediately related to its management.

Inclusion of these two kinds of innovations permits determination of the extent to which the kinds of factors that impinge on their adoption are similar or different, an approach that is not unlike Daft's (1978) "dual core" strategy. Given that production processes on the one hand and administrative processes on the other in hospitals involve different demands and constraints, and given that they may involve different decision making structures with decisions about innovation adoption perhaps being made by different individuals or groups of individuals, there is no reason to believe a priori that the factors explaining innovation adoption in the two cases will be identical. In fact, building on the argument advanced by Downs and Mohr (1976), the important distinction between technological and administrative innovations from the perspective of adoption research may not be so much that they serve different functions but that they imply potentially different decision making processes.

The data base used in the present research was developed by the Program on Organization and Technology at Cornell University. A detailed description of the study procedures and sample is available in Moch and Morse (1977). For present purposes it is important to note that data were collected from both the hospital administrator and the chief of medicine in each hospital in the study. This strategy had the advantage of tapping differing perspectives on some key issues and the additional advantage of providing estimates of reliability of responses on some others. These data were supplemented with data from the American Hospital Association Annual Survey of Hospitals.

The analyses reported in this paper thus used an existing data set. The availability of these data provided an opportunity to address a number of important research questions more comprehensively than they have been addressed previously. The inherent limitation in this situation, of course, is that additional variables could have been included and existing variables might have been conceptualized and measured differently had the study been designed expressly to address the questions of interest. In the view of the authors, the advantages of the existing data far outweighed the potential disadvantages.

Dependent and Independent Variables

The measure of technological innovation is based on hospital responses regarding the presence or absence of 12 new developments in the area of

the diagnosis, treatment, or prevention of respiratory disease. Although concentration on a single area inevitably raises questions about the generalizability of the findings, a strong case can be made that hospital response to innovation in respiratory disease technology is likely to be reasonably representative of response to innovation in medical technology in general because many illnesses that require surgery and, therefore, the services of an anesthesiologist, require respiratory disease technology for anesthesiology and for postoperative care. Furthermore, many illnesses carry respiratory complications which, in turn, require that the hospital have respiratory disease diagnostic and/or therapeutic capacities.

The 12 innovations were chosen from an initial inventory of some 300 items suggested by a group of 15 experts randomly selected from a panel of 75 individuals designated by the National Tuberculosis Association as being the leading experts in respiratory disease in the country. Following consultation with experts, this initial inventory was reduced to 83 items, and these 83 items were then rated by a second group of 24 experts selected randomly from the remaining 60 on the basis of variability in their initial importance, their current importance, the ease with which their benefits could be communicated, and the amount of philosophy change their use might be expected to entail. The selection of the final 12 innovations was made with the help of outside consultants on the basis of these ratings and additional criteria, including researchability and variability in cost, risk, and divisibility.

It is not unreasonable to expect that some innovations might be "better" than others, and that judgments about quality might influence adoption behavior. Although it was not possible to explore this issue in depth, the available data were examined in a preliminary fashion. To accomplish this, the rates of adoption of the four innovations rated highest on both initial and current importance by the expert panel were compared with those rated lowest on both. No significant differences were found. It was impossible to determine whether this means that hospitals do not distinguish among innovations on this dimension or that the expert judgments are questionable or that the right questions were not asked. In any case, these results did not encourage a distinction among the innovations on the basis of quality.

One of the innovations was a surgical procedure, two were new drugs, two were new techniques, and seven were new pieces of equipment. The innovations finally selected were Microaggregated I^{131} for use in lung scanning, Venti mask (disposable), Spirometer, Plethysmograph, Esophaegal balloon, Ultrasonic nebulizer, Blood gas electrode system, Ethambutol, N-Acetylecysteine, LDH determinations, Mediastinoscopy, and Intermittent Positive Pressure Breathing machine (IPPB). The items ranged in cost from low to moderate, in risk to patient from almost none to moderately high, and across the spectrum of divisibility. No extremely costly items or items that were applicable only to highly esoteric diseases were included. Both the hospital administrator and the chief of medicine in each hospital

in the sample were asked to indicate which of the 12 innovations, if any, had been purchased or leased by the hospital.

The measure of administrative innovation is based on hospital responses regarding the use of electronic data processing (EDP) for eight possible managerial functions. Coordination and control are two central functions of management, and the applications of EDP are innovations that can help managers perform both. Potential uses of EDP examined in the study were accounting, admissions, discharges, personnel records, payroll, medical records, research, and patient care. The hospital administrator was asked to indicate whether EDP was currently being used in the organization for any of these eight functions.

These measures of innovation are somewhat different from measures found elsewhere in the literature. For a discussion of the variety of operational definitions of the term found in the organizational literature, see Zaltman et al. (1973). The 12 technological and 8 administrative innovations forming the measures were defined as such in relation to an external standard, in contrast to other studies that have defined innovation in terms of a program or activity new to an organization or in terms of a product, practice, or idea perceived as new by the adopter (Aiken & Hage, 1971; Hage & Dewar, 1973; Rogers & Shoemaker, 1971). There is no question that *perceptions* of newness may influence adoption behavior. These perceptions, however, may vary from one organization to the next, and a definition that focuses on the field as opposed to the adopting unit is more suitable for comparative analysis if several organizations are involved. If the concern is with variability in adoption of innovations across organizations, the definition of what is innovative cannot hinge on the perceptions of the potential adopters. A definition independent of the perceptions or needs of any one organization is required.

For the purposes of the research reported here, extent of adoption behavior is operationally defined as the sum of the respective number of innovations adopted as reported by the hospital administrator. Downs and Mohr (1976) recently criticized the use of such a summated index on the grounds that to do so ignores variations in the characteristics of particular innovations and the possible influence of this variability on adoption decisions. Their point is well-taken. However, Guttman scale analyses of the patterns of adoption across hospitals yielded a coefficient of reproducibility of .92 for the medical innovation variable and a coefficient of reproducibility of .91 for the managerial innovation variable, the magnitudes of which indicate the tenability of the additive assumption underlying the innovation scales. When interest is in *patterns* of adoption and when there is both theoretical justification and empirical support for grouping innovations into categories that have some logical internal consistency, use of indices of adoption seems appropriate.

The correlation between the two innovation measures was .42, suggesting that hospitals that adopt technological innovations also tend to adopt administrative innovations. However, because the shared variance is only 18 percent, it can hardly be argued that the two are redundant.

To examine the extent to which the reports of the hospital administrator and those of the chief of medicine converge, the correlation between the number of medical innovations reported to be adopted by the hospital administrator and the number reported by the chief medical officer was calculated. It turned out to be .78. In addition, 16 case studies were carried out subsequent to the mail survey. The correlation between the hospital administrator responses and the observations of the field researcher was .75 and that between responses of the chief medical officer and the researcher's observations was .86. The reliability of the measure is attributable largely to the use of records, as opposed to recall, as the criterion for determining adoption.

Predictors of Innovation: Individual Variables

Three clusters of predictors of adoption behavior were used—characteristics of organizational leaders, characteristics of organizations themselves, and characteristics of their contexts. The first category includes characteristics of individual people in positions of authority in the subject organization. Considerable debate is found in the literature concerning the effects of leaders on organizational outcomes. Perrow (1970), for example, argued forcefully that "leadership" approaches to organizational analysis represent a form of psychological reductionism and vastly understate the importance of systemic influences on organizational outcomes. Lieberson and O'Connor (1972) found that industry and company factors accounted for more variance in certain indicators of performance in large corporations than did leadership effects. And Salancik and Pfeffer (1977), in their study of mayors' effects on city budgets, found that leadership effects are constrained by factors such as the potency of organized interests, contextual factors over which the leader has virtually no control.

Other research, however, suggests that the characteristics of key organizational actors cannot be ignored. Baldridge and Burnham (1975), for example, observed that organizational position and role appeared to influence innovative behavior (innovation adoption was most strongly influenced by those with power, communication linkages, and with the ability to impose sanctions), a finding compatible with the evidence that those who allocate organizational resources influence innovation adoption (Wilson, 1966; Sapolsky, 1967; Hage and Dewar, 1973).

Given that both the chief of medicine (CM) and the hospital administrator (HA) occupy positions of authority, measures of theoretically relevant characteristics of each of these individuals were included in the analyses. The theoretical perspective within which the hypotheses about the effects of individual factors were framed posits a correspondence between the formal role that an individual plays in an organization and the kinds of interests that person is likely to advocate. Based on such a perspective, it is argued that a chief of medicine, whose formal role is to preside over the medical activities of the hospital, would be likely to champion innovations

in the hospital's core technology. A hospital administrator, on the other hand, would be likely to be particularly interested in innovations that promise to further managerial efficiency or effectiveness. It would be expected, therefore, that characteristics of the chief of medicine would be more strongly associated with the adoption of innovations in the core technology than in administration, whereas characteristics of the hospital administrator would be more strongly associated with adoption of administrative innovations than with innovations in the core technology.

Existing theoretical perspectives on adoption suggest the importance of four sets of individual level variables: the job tenure, cosmopolitanism, educational background, and nature of organizational involvement of leaders. A positive relationship generally has been found in adoption research between adoption behavior and length of leader service (Rogers & Shoemaker, 1971). Although this relationship may be curvilinear in the extreme, the argument is that longevity in the job is a surrogate for systemic legitimacy and for knowledge of how to navigate the political waters in order to obtain desired outcomes.

Alternatively, it could be argued that new leaders with fresh perspectives and unfettered by obligations to particular organizational constituencies might be more likely to advocate and support innovations. Thus, a negative relationship between job and adoption would be expected. In the absence of empirical support for this rival hypothesis, it is hypothesized here that the job tenure of the chief of medicine and hospital administrator would be positively related to adoption behavior. It thus was hypothesized that *HA tenure is positively related to administrative innovation and CM tenure is positively related to the adoption of technological innovations.*

Although there have been some exceptions (Counte & Kimberly, 1974), researchers generally have found that cosmopolitanism is associated with higher receptivity to innovation (Becker, 1970a, 1970b; Rogers & Shoemaker, 1971). Again, it was felt that the orientations of leaders in both the technical and administrative subsystems of the hospital might influence decisions about adoption. It was hypothesized that *HA cosmopolitanism is positively related to adoption of administrative innovations and CM cosmopolitanism is positively related to adoption of technological innovations*. These two variables measure the extent to which the hospital administrator and chief of medicine, respectively, have contacts with professional colleagues outside the immediate work setting. The rationale for this pair of relationships is that cosmopolitans would be more likely to be exposed to new developments in the field.

The educational background of leaders has been found consistently to be related to adoption behavior in previous research. The higher the level of education, the more receptive an individual has been found to be to innovation (Becker, 1970a, 1970b; Rogers & Shoemaker, 1971). Because there was no variance in educational levels for the chiefs of medicine—all were M.D.s—they were not included in the analyses. For hospital administrators, however, both the *level* and *substance* of their educational

experience varied widely, and it was felt that both might influence adoption. In line with previous research, *HA educational level was hypothesized to be positively related to adoption of both kinds of innovations.* In the case of education substance, it was reasoned that hospital administrators trained specifically in administration might be expected to be more receptive to administrative innovation than would administrators with other kinds of educational backgrounds.

The final individual level variables were included based on the hypothesis that greater involvement in policy (as opposed to operations) is associated with receptivity to innovation (March & Simon, 1958; Cyert & March, 1963). Three variables reflect this involvement. HA committee participation reflects the extent to which the hospital administrator participates in a number of policy setting committees for medical matters, and it was hypothesized that the more extensive the participation, the more likely the hospital administrator would be coopted by the medical staff and hence the more receptive he would be to technological innovation. HA involvement in medical activities and CM involvement in administrative activities indicate the extent to which the hospital administrator and chief of medicine are more broadly involved in hospital activities than the stereotypes characterizing their respective roles would suggest. Operating theoretically in a fashion akin to the HA committee participation variable, it is posited that *broader involvement in hospital affairs will be positively related to adoption behavior.*

Predictors of Innovation: Organizational Variables

Many organizational researchers have argued that the structural characteristics of an organization significantly influence its adoption behavior. The contention is that certain features of organizations themselves either facilitate or encourage adoption of innovation. Five variables in particular consistently have been found to be related to adoption and therefore have been included in our analyses.

Nearly all researchers hold that centralization is important in a theoretical sense. Although the relationship between centralization and adoption of innovation has been found to be positive in some cases, in others the relationship has been negative. Rarely, if ever, has it been found to make no difference whatsoever. In the absence of a persuasive and comprehensive theory about the effects of centralization on innovation adoption, the evidence suggests that the nature of the relationship may depend on the type of innovation in question and its relationship to key decision makers. An innovation in the core technology where that technology is applied by professionals who are more or less autonomous, as in the case of physicians working in hospitals, might be adopted more frequently in decentralized authority structures. On the other hand, an innovation in the administrative subsystem might be expected to be adopted more frequently in a centralized authority structure, where the will of the chief executive can be

more easily imposed. It thus was hypothesized that *centralization is negatively related to the adoption of innovations in the core technology and positively related to the adoption of administrative innovations.*

Specialization represents the number of different medical specialties found in the hospital. To the extent that large numbers of different specialities are linked to the hospital's core technology, it can be said to be highly specialized. Employment of a variety of specialists perforce provides access to broader knowledge of new ideas, techniques, and products. Thus one may expect to find *a positive relationship between specialization and the adoption of innovations in the core technology*. And because increasing the number of medical specialties presumably generated increasingly complex problems of coordination and control, one would expect to find *a positive relationship between specialization and the adoption of administrative innovations* (Aiken & Hage, 1971; Corwin, 1972; Hage & Aiken, 1967; Mytinger, 1968).

The third organizational level variable, *size, generally is held to be positively related to adoption*. Most frequently, this relationship is attributed to economies of scale, which enhance the feasibility of adoption (Baldridge & Burnham, 1975; Moch & Morse, 1977). A more complete theoretical treatment of size and its measurement is presented in the next section of the paper.

Functional differentiation represents the extent to which the hospital is divided into a number of subunits. *Functional differentiation generally is hypothesized as leading to increased adoption of innovations* (Hage & Aiken, 1967; Blau, 1973; Heydebrand, 1973). The rationale for a hypothesized positive relationship between functional differentiation and the adoption of administrative innovations is that problems of coordination and control are exacerbated when organizations are formally divided into larger numbers of functional units. Adoption of innovations in EDP represents one potential solution to these problems. The positive relationship hypothesized between functional differentiation and the adoption of technological innovations is based on the premise that a functionally differentiated organization creates multiple interest groups and multiple demands for elaboration of the core technology. Inasmuch as innovations in respiratory disease technology support developments in other medical technologies, it is posited that *organizations that are highly differentiated functionally will be adopters of technological innovations*.

The final organizational level variable, external integration, represents the extensiveness of a variety of mechanisms that increase the probability that information about innovations will enter the organizational system. Research done in cases in which the individual is the adopting unit (Coleman, Katz, & Menzel, 1966; Becker, 1970a, 1970b; Burt, 1973), generally finds communications to be central in the adoption process. Although little research has been done at the organizational level, *a positive relationship between external integration and hospital adoption of innovation* has been found (Kimberly, 1978). Building on this perspective, we hypothesized a positive relationship.

Predictors of Innovation: Contextual Variables

The importance of the organization's environmental context for innovation has been acknowledged conceptually, but rarely examined empirically. The first contextual variable, competition, indicates whether there are other hospitals in the area. This variable was included because it is generally held by economists that *competition increases the likelihood of adoption of innovation* (Utterback, 1974). The second contextual variable, size of city, indicates whether the hospital is located in a rural or urban area. Although there is very little evidence, some researchers have used city size as a measure of environmental complexity (Heydebrand, 1973). There appears to be an implicit hypothesis that *the larger the city, the more likely an organization is to adopt innovations*, but this may be due to the correlation between city size and other variables. The final contextual variable is the age of the hospital. Although there is little evidence, based on the perspective of Stinchcombe (1965) it would seem reasonable to expect *a positive relationship between age and adoption behavior.* Older hospitals that have both a well-defined resource base and a demonstrated high survival potential might be expected to adopt innovations as a way of insuring their status in the community. (A complete description of the predictor variables is available from the first author.)

Size and Innovation

Two questions about the role of size were examined prior to the overall analyses. The first question has to do with its theoretical relationship to adoption behavior. It is generally held that innovation adoption is positively related to organizational size, and a positive relationship has been found reasonably consistently at the empirical level. The factors that lie behind this relationship may not be the same in all cases, however. Theoretically, there are at least two alternatives. First, size and adoption behavior may be positively related because increasing size creates a "critical mass" which justifies the acquisition of particular innovations. From this perspective, it can be argued that increasing size *facilitates* adoption behavior. Those organizations with greater volumes of activity may simply be better able to afford innovations.

An alternative explanation is that for certain classes of innovation, organizational size *necessitates* adoption behavior. Just as organizations often tend to become differentiated and formalized in the face of increasing size as a means of rationalizing and coordinating their activities, it may be the case that certain administrative innovations become necessary as a result of increasing size. Although the argument about the facilitiating effects of size might be advanced in this case as well, the important distinction is that organizations may have little choice in the matter: increasing size may create uncertainties that demand innovative behavior. Thus, in a theoretical sense the effects of size may depend on the nature of the

innovation in question. A positive relationship between size and adoption behavior should not be assumed. See Mohr (1969) and Thompson (1969) for empirical and theoretical work that involves a negative relationship.

The second question has to do with the measurement of size and consists of two basic problems. By far the most common measure in organizational research is the number of employees (Kimberly, 1976). With regard to hospitals, however, measures that have been used (in order of frequency) are number of beds (a measure of capacity), total assets (a measure of resources), and number of personnel (a measure of work force). Even these do not exhaust the range of possibilities. Moch (1976) and Moch and Morse (1977), for example, conceptualized size as input volume and measured it as the logarithm of the annual number of patient admissions. What, then, is the best measure for present purposes?

To answer this question intercorrelations were calculated for four alternative size measures: beds, total assets, total employees, and full-time equivalent employees (full-time employees plus one half of the number of part-time employees). These measures are highly related, with all correlations exceeding .85. Although this pattern of relationships should not be assumed to obtain in other settings (Child, 1973), the results suggest that use of any of the four alternative size measures (with the possible exception of total assets) could be justified on empirical grounds. Because the dominant trend of hospital researchers is to use the number of beds as the operational definition of size, that measure was used in the research reported here for the sake of comparability.

The second issue with regard to size has to do with the appropriateness of logarithmic transformations of size variables. The most common rationale for the log transform is to reduce the variance in the distribution of the values of size across observations. The implicit justification for the log transform is that when the values of one variable are highly skewed—as is often the case with size—the magnitude of its resulting correlation with other variables can be very strongly affected by extreme scores. In using the log of size in a correlational or regression analysis, one assumes a curvilinear relationship with other variables in the analysis. However, the assumption of curvilinearity is rarely discussed. It thus appears that organizational researchers often fail to recognize the theoretical import of the log transformation.

Researchers on occasion have demonstrated the existence of a curvilinear relationship between size and other organizational properties (Blau & Schoenherr, 1971; Child, 1973), and in the case of organizational innovation, it is conceivable that size is related to adoption behavior in a curvilinear fashion. If one subscribes to the critical mass perspective that organizations of varying sizes are able to "justify" various levels of innovation adoption, it appears reasonable that at the low end of the size distribution the relationship between adoption behavior would be approximately linear. At some point, however, organizations will have the critical mass necessary to acquire most or all innovations, and size increments beyond

this level are not likely to lead to increased adoption. Over the entire range of size, then, the relationship may be curvilinear.

Curvilinearity exists when the correlation between a variable and the log of size exceeds the correlation between the raw size measure and that variable. Although this test for curvilinearity is rather straightforward, it is infrequently applied. To explore the issue of curvilinearity in the present sample, logged and unlogged size measures were correlated with both innovation measures. For each pair of correlations, the significance of the difference of correlations was computed as a test of the curvilinearity assumption. The results, which are presented in Table 1, suggest that *the relationship between size and innovation depends on the particular type of innovation under consideration*. For innovations in medical technology, all four size measures when logged demonstrated significantly stronger relationships to innovation adoption than the unlogged measures. For administrative innovation, they did not.

TABLE 1
t-Statistics for Differences Between Correlations of Innovation Measures with Size and Log of Size

	Correlation Between Technological Innovation and			*Correlation Between Administrative Innovation and*		
	Size Measure	*Log of Size Measure*	*t-Statistic for Difference*	*Size Measure*	*Log of Size Measure*	*t-Statistic for Difference*
Beds	.70	.75	2.96*	.52	.52	.00
Total assets	.64	.72	3.51**	.49	.50	.36
Total employees	.67	.75	4.10**	.52	.53	.40
Full-time equivalent employees	.67	.75	4.09**	.52	.53	.40

*$p<.01$
**$p<.001$

This difference is not unimportant and is used in subsequent analyses. The log of the number of beds is used as the size measure in analyses concerned with technological innovation, whereas the raw value is used in the analyses focusing on the adoption of administrative innovations. The larger issue, of course, is that logarithmic transformations should not be routinely used. They may be appropriate in some cases but not in others.

RESULTS

The analyses focused on two distinct, but related questions. First, in the context of the bivariate hypotheses described earlier, what is the relative significance empirically of each of the individual, organizational, and contextual classes of variables? And, second, within classes and on an overall basis, which specific variables make the largest contribution to explained

variance in each of the dependent variables when all other variables are held constant? The results from both questions, taken together, provide data on the extent to which different or similar variables account for adoption of the two types of innovation and provide indications of the relative strengths of individual, organizational, and contextual level explanations of variance in adoption behavior.

Eight multiple regression equations were estimated to assess the effects of the predictor variables both within and across classes. The first six regressions examine the effects of individual, organizational, and contextual variables separately on technological innovation and then on administrative innovation. The final two examine the combined effects of all variables on the two types of innovation. Table 2 presents the correlations among all variables included in these analyses.

Technological Innovation

The first three regressions examine the separate effects of individual, organizational, and contextual factors on adoption of technological innovation, and the results are presented in Table 3.

The potential problem of multicollinearity in the regression results has not been ignored. Unfortunately, there is little consensus among statisticians on two critical operational points. First, what *level* of correlation among *how many* independent variables creates a "problem"? And, second, how should one interpret regression results in those situations in which the problem may exist? With regard to the former, Blau and Schoenherr (1971) used substantive interest as a general criterion for the inclusion of independent variables, although as a rule of thumb they did eliminate one independent variable in cases in which correlations exceeded .82. In the absence of other criteria, this solution does not seem unreasonable. With regard to the issue of interpretation, the reader is urged to use whatever caution(s) his or her own training and/or biases suggest.

With respect to the effects of individual level variables, the results suggest that technological innovation is positively affected when the hospital administrator is highly educated, does not participate extensively in committees dealing with matters of medical policy, is relatively heavily involved in medical activities, and has served in his role for a relatively long period of time, and also when the chief of medicine is relatively actively involved in administrative affairs.

The results, which in regression terms account for 21 percent of the variance in innovation, are somewhat counter-intuitive. The hospital administrator is a more central figure in the adoption of technological innovations than is the chief of medicine. Because the innovations examined are medical as opposed to administrative, it would not have been surprising had the chief of medicine had a more significant impact.

The regression results for the organizational level variables, which account for 62 percent of the variance in technological innovation, indicate

TABLE 2
Correlations Among All Variables
($N = 210$)

Variables	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*
1. Technological innovation	—																		
2. Administrative innovation	.42	—																	
3. HA tenure	.13	.09	—																
4. CM tenure	.01	-.03	-.11	—															
5. HA cosmopolitanism	.04	.19	.33	-.06	—														
6. CM cosmopolitanism	.11	-.02	-.07	.01	.00	—													
7. HA educational substance	.06	.14	-.25	-.08	-.04	-.02	—												
8. HA educational level	.23	.26	-.19	-.11	-.04	.04	.40	—											
9. HA committee participation	-.29	-.15	-.11	.04	-.07	-.01	-.06	-.07	—										
10. CM involvement in administrative activities	.20	.04	-.02	.00	-.02	.16	.02	.11	-.06	—									
11. HA involvement in medical activities	.12	.10	.05	.00	.11	.07	-.06	-.10	.08	-.06	—								
12. Centralization	-.38	-.13	-.07	.02	-.17	-.08	.00	-.07	.01	-.08	-.02	—							
13. Specialization	.70	.46	.19	-.06	.08	.11	.08	.25	-.36	.10	.08	-.32	—						
14. Size	.69	.52	.13	.02	.05	.10	.15	.29	-.32	.12	.10	-.30	.75	—					
15. Functional differentiation	.70	.47	.10	-.03	.07	.08	.13	.31	-.40	.22	.10	-.29	.72	.77	—				
16. External integration	.55	.37	.06	.02	.10	.12	.00	.08	-.18	.21	.05	-.33	.62	.58	.58	—			
17. Competition	.41	.25	.03	-.05	.02	-.10	.02	.27	-.17	.04	.06	-.25	.44	.35	.40	.27	—		
18. Size of city	.47	.26	.09	-.02	.01	.02	.08	.19	-.23	.17	.18	-.18	.56	.47	.51	.44	.42	—	
19. Age	.35	.21	.15	.07	.02	.03	.08	.26	-.19	.06	-.04	-.22	.52	.50	.49	.33	.28	.30	—

TABLE 3
Results for Regression of Technological Innovation on Individual, Organizational, and Contextual Variables

Individual Variables			*Organizational Variables*			*Contextual Variables*		
Variable	*Beta*	*SE*	*Variable*	*Beta*	*SE*	*Variable*	*Beta*	*SE*
HA tenure	.17*	.070	Centralization	−.14**	.046	Competition	.21**	.065
CM tenure	.06	.064	Specialization	.17*	.082	Size of city	.33***	.066
HA cosmopolitanism	−.03	.067	Size (log of beds)	.34***	.091	Age	.19**	.062
CM cosmopolitanism	.07	.064	Functional differentiation	.19*	.076			
HA educational substance	.00	.070	External integration	.10	.058			
HA educational level	.25***	.070						
HA committee participation	−.27***	.064						
HA involvement in medical activities	.16**	.064						
CM involvement in administrative activities	.15*	.064						
$R^2 = .21$			$R^2 = .62$			$R^2 = .30$		

*$p < .05$
**$p < .01$
***$p < .001$

TABLE 4
Results for Regression of Administrative Innovation on Individual, Organizational, and Contextual Variables

Individual Variables			*Organizational Variables*			*Contextual Variables*		
Variable	*Beta*	*SE*	*Variable*	*Beta*	*SE*	*Variable*	*Beta*	*SE*
HA tenure	.11	.073	Centralization	.05	.063	Competition	.16*	.074
CM tenure	.05	.067	Specialization	.09	.099	Size of city	.14	.075
HA cosmopolitanism	.15*	.070	Size	.34**	.104	Age	.12	.071
CM cosmopolitanism	−.03	.067	Functional differentiation	.12	.100			
HA educational substance	.05	.073	External integration	.06	.079			
HA educational level	.27***	.073						
HA committee participation	−.10	.067						
HA involvement in medical activities	.13	.067						
CM involvement in administrative activities	.02	.067						
$R^2 = .15$			$R^2 = .29$			$R^2 = .10$		

*$p < .05$
**$p < .01$
***$p < .001$

that the extent of integration into the hospital's external information environment is the only organizational level variable that does not account for unique variance in the dependent variable. The pattern and strength of the relationships reveal that high adopting hospitals tend to be large, are specialized, are highly differentiated, and have a tendency for decisions to be made near the level of the department heads.

All three contextual level variables have significant partial regression coefficients. The evidence suggests that high adopting hospitals tend to be located in urban areas, are faced with competition from at least one other hospital, and are older. These three contextual variables together account for 30 percent of the variance in technological innovation.

Administrative Innovation

The next three regressions examine the effects of individual, organizational, and contextual factors on adoption of administrative innovation, and the results are presented in Table 4. Considering the individual level variables first, two explain significant, unique variance in adoption behavior. Adoption is positively affected when the hospital administrator is highly educated and cosmopolitan. None of the variables pertaining to the chief of medicine was significant. The individual level variables account for 15 percent of the variance in adoption of administrative innovations.

The influence of organizational variables on administrative innovation is considerably weaker than on technological innovation. Of the five, only organizational size accounted for unique variance in the dependent variable; the regression equation explains 29 percent of the variance in administrative innovation.

The contextual variables also are less effective predictors of administrative than of technological innovation, with only the presence of competition in the area having a significant partial regression coefficient. The regression equation accounts for 10 percent of the variance in administrative innovation, and adoption behavior is fostered when the hospital faces competition in the local area.

The results of these six regressions provide evidence with which to answer the question regarding the relative significance of the different classes of variables for each type of innovation. Although the independent variables are less effective predictors of administrative innovation than they are of technological innovations, the results underline the importance of the organizational level variables, which, for both dependent variables, account for twice the variance of the next best set of predictors. In terms of the question about *which* variables within the three classes explain variation in the two types of innovation, important differences apparently exist. The fact that both HA and CM involvement in their counterparts' activities enhanced adoption of technological but not administrative innovations suggests that the March and Simon hypothesis about the relationship between involvement in policy as opposed to operations and receptivity to innovation needs to be refined. In an organization such as a hospital

where there is a dual authority structure and presumably high potential for conflict over resource allocation decisions, innovations in those areas that engage both subsystems—such as innovations in the core technology—are facilitated when leaders from each subsystem are actively involved in the affairs of the other subsystem. Such activity provides an opportunity for the kind of bargaining and negotiation required when potentially conflicting interests are at stake to take place.

Size was the only organizational factor enhancing adoption of administrative innovations, whereas it was one among several organizational factors enhancing adoption of technological innovations, suggesting a more complex organizational level explanation for the latter. Age and size of city were unrelated to adoption of administrative innovation but were related to adoption of technological innovation, again suggesting, though by no means confirming, the existence of different processes accounting for their adoption.

Relative Importance of the Predictors

To what extent do specific individual, organizational, and contextual variables account for unique variance in each of the two dependent variables and what is their relative import when all three are considered simultaneously? For innovations in medical technology, the results for all 17 predictor variables are shown in Table 5. As the table shows, five variables explain a significant amount of unique variance in adoption behavior in a regression equation that accounts for 65 percent of the variance in adoption. The apparent dominance of the organizational variables discussed above

TABLE 5
Results for Regression of Technological Innovation on All Variables

Variable	*Beta*	*SE*
HA tenure	.05	.050
CM tenure	.07	.044
HA cosmopolitanism	−.07	.047
CM cosmopolitanism	.00	.045
HA educational substance	.03	.049
HA educational level	.03	.052
HA committee participation	−.01	.049
HA involvement in medical activities	.04	.046
CM involvement in administrative activities	.05	.046
Centralization	−.15**	.047
Specialization	.18*	.086
Size (log of beds)	.39***	.094
Functional differentiation	.17*	.080
External integration	.10	.060
Competition	.06	.052
Size of city	.00	.057
Age	−.15**	.053
$R^2 = .65$		

*$p<.05$
**$p<.01$
***$p<.001$

was confirmed; none of the nine individual variables was a significant predictor of innovation, and only one of the contextual variables was significant. Adoption of technological innovation tends to be most prevalent in organizations that are large, specialized, functionally differentiated, and decentralized.

Interpretation of the effects of age is more complex, as can be seen by comparing Table 3, which presents the results of the regression of technological innovation on the contextual level variables, with Table 5, which presents the results of the regression of technological innovation on all of the predictor variables. Although the zero-order correlation between adoption of technological innovations and hospital age is .35, the respective beta values in Tables 3 and 5 are .19 and -.15. As indicated in Cohen and Cohen (1975), a partial regression coefficient that falls outside the range from .00 to the value of the zero-order correlation between the independent and dependent variables (in this case, .35) indicates that net suppression is occurring. Because the beta value for age in Table 5 is negative, such a situation exists.

To examine the interpretive significance of net suppression in the absence of a theoretical perspective that had predicted it a priori, a series of multiple regression equations in which age and each of the other predictor variables were paired was estimated. These analyses revealed that size and specialization suppress a portion of the variance in age that is irrelevant to the adoption of technological innovations. As a result, removing the portion of the variance in age associated with size and specialization results in a negative relationship between age and adoption of technological innovations.

The explanation of this phenomenon, albeit post hoc, concerns the incentive structures for innovation during the course of an organization's life cycle. As suggested earlier, a possible explanation of hospital adoption behavior for innovations is that the increased scope of a hospital's activities and workload *facilitates* adoption. Size and, consequently, specialization are positively related to adoption of innovative medical technologies. When organizational size and specialization are controlled for, it is argued that the negative coefficient for age occurs because innovation adoption is most likely in young hospitals—those hospitals that are not yet "established" and whose viability is yet to be insured. Such hospitals are likely to use innovation in the core technology as a strategy for defining a niche. Again controlling for size and specialization, older hospitals are less likely to adopt innovations because in most cases they have achieved a level of security and have already created a niche in the environment.

Table 6 presents the results of the regression of administrative innovation on all three classes of variables. As the table indicates, two variables provide a unique contribution to the explanation of variance in the dependent variable. Specifically, hospitals that are adopters of administrative innovations tend to be large and have hospital administrators who are cosmopolitan. The regression equation accounts for 36 percent of the

TABLE 6
Results for Regression of Administrative Innovation on All Variables

Variable	*Beta*	*SE*
HA tenure	.04	.068
CM tenure	.03	.060
HA cosmopolitanism	.15*	.063
CM cosmopolitanism	-.07	.061
HA educational substance	.03	.066
HA educational level	.14	.071
HA committee participation	.08	.066
HA involvement in medical activities	.05	.062
CM involvement in administrative activities	-.03	.062
Centralization	.08	.064
Specialization	.14	.108
Size	.34**	.104
Functional differentiation	.15	.106
External integration	.09	.082
Competition	.05	.070
Size of city	-.10	.075
Age	-.13	.072
$R^2 = .36$		

*$p < .05$
**$p < .01$

variance in adoption behavior and fails to attribute significance to the hospital administrator's educational level or the presence of competition in the area, both of which were significant when administrative innovation was regressed on each category of independent variables separately. Although the evidence is not as overwhelming in this case as it is in the case of technological innovation, the import of organizational variables cannot be ignored; hospital size clearly is the best predictor of adoption of administrative innovation as it was of technological innovation. It should be noted that a sign reversal for the age variable occurred here as well, but the partial regression coefficient was not significant.

CONCLUSIONS AND IMPLICATIONS

This paper has reported the results of a comparative analysis of the effects of variables from three different levels of analysis on organizational adoption of two different types of innovation. The analyses were designed to confront three issues in previous work on organizational innovation: the focus of most studies on a single innovation or class of innovations; the frequent use of sample sizes too small to permit application of multivariate analytic techniques; and the scarcity of studies examining the combined effects of individual, organizational, and contextual factors on adoption of innovation.

Three primary conclusions can be drawn on the basis of the analyses presented here. First, the variables used in the study were much better predictors of the adoption of technological innovations than of administrative innovations. When combined, they explained 65 percent of the variance in technological innovation as compared with 36 percent of the variance in administrative innovation.

Second, adoption of the two different types of innovations was not influenced by identical sets of variables. Analysis of the separate effects of variables from the three levels of analysis revealed that only one variable from each level was a significant predictor of adoption for both types of innovation. The educational level of the hospital administrator, the size of the organization, and the presence of competition in the local environment were significant predictors of both technological and administrative innovation in the separate analyses. In the analysis of their combined effects, only size was a significant predictor of both types.

Third, organizational level variables—and size in particular—are indisputably better predictors of both types of innovation than either individual or contextual level variables. In the case of technological innovations, the only nonorganizational level variable that emerged as a significant predictor was the age of the hospital, which had been conceptualized as a contextual variable. And in the case of administrative innovation, the only significant nonorganizational level predictor was the cosmopolitanism of the hospital administrator, although the educational level of the hospital administrator and the age of the hospital approached significance. Although it was anticipated that organizational level variables would play a role in predicting innovation, their empirical dominance was not expected.

Certain constraints on the generalizability of the findings should be noted. The study was carried out in hospitals. It remains to be seen whether similar variables would be good predictors of adoption behavior in other kinds of organizational settings. Furthermore, although the choice of variables was guided by prior theory and research, the strategy of using an existing data base limited the range of variables available for analysis. Hence, other variables not included among those used here might prove to be good predictors. Finally, the two types of innovations examined were both "technological" in the narrow sense of the term, even though their organizational significance was quite different, and it should not be assumed that similar results would be found with other types of innovation.

What are the implications of the results for theory and research on organizational innovation? The independent variables *were not* equally effective in predicting adoption of the two types of innovation, and *different* variables accounted for their adoption. This means that, at least in the short run, theory construction efforts should focus on middle range theories that help explain adoption of particular types of innovation. More inclusive theories might ultimately emerge, and such theories are desirable. But at present, although it may be true, for example, that initiation and implementation are two distinct "stages" in the process of innovation adoption—as Zaltman et al. (1973) and Duncan (1977) have asserted—it is not obvious that different types of innovation have the same organizational salience or engage in identical organizational processes in the course of their adoption. The decision to adopt an innovation will be affected not only by the performance characteristics of the innovation but

by the way in which various key actors in the organizational system assess its likely impact on them and their prerogatives. There thus is no reason to expect that a given set of variables will be related to the adoption of different types of innovation in the same way.

Three additional implications should be noted. First, the research dealt only with situations in which it could be determined that an adoption decision actually had been made. The procedure was then to assign a score to each hospital based on the total number of adoptions that had taken place for each type of innovation. This procedure places this research in the same domain as most other research on organizational innovation in that adoption takes on implicitly positive connotations. Innovation is good and more innovation is better. The effort to distinguish between the desirability of the technological innovations revealed that adoption does not appear to be influenced by either the current or initial importance of the sample of innovations as determined by the panel of experts used. Can it be that the quality of an innovation—as difficult as "quality" may be to determine—does not significantly influence adoption decisions? One would think that this would be a particularly important criterion with regard to production process innovations in hospitals where the raw material on which work is performed is patients with a variety of illnesses and intensity of suffering. Yet the data suggest at the very least that the answer is not obvious. Research focused on the politics of decision making in which the perspective of the researcher was critical, as opposed to implicitly supportive, of innovative adoption would help shed light on this important question.

Second, many questions remain to be answered about post adoption behavior in organizations. In particular, how and under what conditions does exnovation, that process whereby an organization decides to divest itself of an innovation that it had previously adopted, occur? This question is important because innovations in organizations have variable life expectancies. They ebb and flow, and the adoption of one innovation may be made possible by another's exnovation. Research that focuses exclusively on adoption simply does not consider what happens subsequently, and adoption certainly is not the only critical event in the life of an organizational innovation (Brewer, 1980; Kimberly, 1981).

Finally, the explanatory dominance of the organizational level variables in this study requires some comment. It is possible, of course, that had other individual and contextual level variables been included in the analyses, this dominance would have been diminished, particularly in the case of administrative innovation that left a great deal of variance unexplained. And, as has been argued elsewhere (Kervasdoué & Kimberly, 1978), there may be important cross-national differences at the institutional level that will influence the extent to which organizational effects predominate.

On the other hand, adoption of the two types of innovation does seem to be organizationally anchored and subject to organizational level explanations, although the explanations are different. In the case of technological innovation, it does appear reasonable to expect that adoption will

be higher in hospitals that are relatively large, specialized, and functionally differentiated. If specialization and functional differentiation are seen as organizational responses to problems encountered in treating the increasingly heterogeneous acutely ill patient population, which is likely to be the domain of the kinds of hospitals included in this sample, then adoption of innovations in the core technology can be seen as one vehicle for both solving increasingly complex and nonroutine problems in the technical core and enhancing the attractiveness of the hospital to physicians as a place to treat patients. In the case of administrative innovation, the explanation is more straightforward but no less organizationally anchored. In large, specialized, and functionally differentiated hospitals, generic problems of coordination and control are exacerbated. Adoption of electronic data processing capabilities is an effort by hospital management to maintain control in the face of operations of relatively large scale.

In brief, decisions to adopt technological innovations are driven by the needs of those in the technical core, needs that are a function of decisons previously taken with regard to domain, structure, and scale. Decisions to adopt administrative innovations are driven by needs of managers to insure coordination and control, needs that are attenuated in large facilities. Particularly given the complexity of the core technology and the demands of coordination and control inherent in the kinds of organizations considered here, the finding that organizational variables are more potent predictors of innovation adoption than are the characteristics of leaders is consistent with the contention of Perrow (1970) and the findings of Lieberson and O'Connor (1972) and Salancik and Pfeffer (1977) that leaders have limited impacts on organizational outcomes.

It is not argued that organizational level variables should necessarily be expected to be as efficacious in a predictive sense with all types of innovation. It may be that adoption of the two types of innovation studied here, because they are both technologically oriented, is more likely to be organizationally determined than, for example, nonhardware programmatic innovations. However, when taken together, the results of this study are compelling and add some data to the debate between micro and macro organizational theorists that cannot be ignored.

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Contents

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Section 5: Actors, Networks and Alliance in e-Health

The Three Rivers Telehealth Network: Creation of a Distributed Network.

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INTRODUCTION

Although the concepts of telemedicine and e-health have been around for many years, it has only been in the past several decades that it has become an option for rural health. Each year the capability increases and the costs continue to decline. In rural communities throughout the United States equipment and telecommunication links are increasingly affordable. However, along with the decreasing cost, the funding for new programs is also decreasing. State budgets have never been tighter, and Federal grant programs are more and more competitive, one reason why growth in rural areas has been slow. Nevertheless, grant funding and federal assistance that is available helps communities afford to initiate telemedicine programs (http://telehealth.hrsa.gov/grants/funds.htm). In addition, with changes in Medicare reimbursement structures, telemedicine is being reimbursed more today than perhaps only five years ago, making it worth the investment in time and effort to attempt to obtain funding.

Using the layers of an onion model, as described in the introduction of this book, when the Virginia Commonwealth University Health System (VCUHS) set out to establish a network, the culture of the community was assessed, the available technology was considered, including connectivity, leaders and champions were sought in the VCUHS as well as in Three Rivers Health District, and alliances were developed to create strong relationships to form the network. The network members learned about telemedicine and explored its uses in education, and as a useful significant adjunct to health care where distance is a challenge. As access issues continue

to be a challenge, the role of a strong network becomes even more important to provide high quality health care to this rural community.

CREATION OF THE NETWORK

Sustaining telemedicine programs is another challenge altogether. Studying health care in rural communities is paramount in creating successful networking strategies for a telemedicine project to be sustainable. The role of the people in the network in a rural community is much more important than the connections created through telecommunications. The dynamics of the health care providers, patients and others within the community can be of benefit to the entity of the network, or tear it apart. Much like Seale, et al, has stated in an earlier chapter of this book, Three Rivers Telehealth Network was created with emphasis on strategic partnerships, identifying local champions, working with a dedicated team, securing buy-in from management as well as local government representatives and obtaining community support. These efforts were necessary to raise chances for long-term success. The emphasis in creating this network has to be on the people and relationships rather than the technology. The strength of these relationships was tested when the grant proposal was not accepted, delaying funding for the initial phase. The alternate plan went into effect right away. The relationships and the increased access to healthcare offered through the creation of the network proved to be more important than receiving the initial funding.

SETTING

In the Commonwealth of Virginia, the challenges of rural medicine are evident in the Three Rivers Health District in Eastern Virginia. This area consists of ten rural counties surrounded on three sides by rivers (Potomac River on the north, North Anna, Pamunkey and York River chain on the south) and the Chesapeake Bay on the east. The population is diverse, within the ten

counties. A few of the counties serve as retirement communities, one is considered a "bedroom community" for the greater Richmond area. However, these counties have a lower income than the state average and all are medically underserved. The community of Three Rivers Health District has a saying about people who live in their community. If you reside in Three Rivers, you are a "from here", if you have moved into the area, you are a "come here". As is typical of many rural areas, it is much more difficult to find acceptance as a "come here."

When the VCUHS began to investigate the idea of creating a Telemedicine Network in Three Rivers, it knew that being a "come here" was not going to help establish a successful, sustainable network. In order to gain acceptance, from the beginning, the VCUHS, an academic, urban hospital, took on the role of coordinator but did not assume the exclusive role of provider. The VCUHS studied the health statistics and the number of health-related visits to the VCUHS clinics from Three Rivers. This study indicated that 16,000 visits were made in 2001 from the ten counties included the Three Rivers Health District. Moreover, this region's health statistics were alarming. The death rate of the citizens in Three Rivers is much higher than in the Commonwealth of Virginia for cardiovascular disease (22%more deaths 1996-2000), pulmonary disease (16% more deaths 1996-2000), and many types of cancer (26% more deaths 1996-2000).[1] These health disparities, and the high number of clinic visits prompted the VCUHS and several health care providers in Three Rivers to begin to formulate a plan for implementing a telemedicine program to link providers and patients in a distributed telemedicine network in the area.

The Three Rivers Telehealth Network: Creation of a Distributed Network.

PLAN

A distributed network was chosen as a more effective model than a hub-and-spoke model. In this model, members can connect to each other, providing education and/or consultations to and from any network site. In the hub-and-spoke model, all peripheral sites (spokes) connect to a central site (hub) to receive care/education. Three Rivers has several specialist groups and three hospitals serving the area. Since it is well documented that rural physician recruitment and retention is a problem,[2,3] it was made clear from the beginning that the VCUHS did not want to take patients from the rural physicians, but rather, to enhance their ability to provide care, and supplement specialty care where it was not locally available. Hicks et al describes the importance of rural community pride to the rural population, as "Members of the community often view their local hospital with civic pride and recognize that the hospital is a key factor in efforts to attract and retain physicians and other health care personnel and resources."[4] Recognizing this, the VCUHS sought and received the support of the Three Rivers Health District Health Director during the early planning stages, and worked closely with hospital administrators, community physicians, patients, and regional health departments determining the area health care needs and possible solutions. It was determined early that some health care needs (such as cardiology, where there are sufficient cardiologists in the area) could be met by local physicians and practitioners, and some needs would require the VCUHS staff support (such as neurology, where there are significant shortages in the area). The year after the network was initiated the community lost all inpatient obstetrical services. This crisis has made the network even more important. As leaders of the network, it becomes even more important and more valuable to obtain full funding to link all participants.

Another need identified through requests from the healthcare professionals, was the lack of available continuing education opportunities. According to the State and Federal Bureau of Primary Care, Three Rivers consists of several physician shortage counties. Therefore, travel for required continuing medical education further reduces the number of available physicians at any one time, thus impacting health care responsiveness. In order to meet the needs of the physicians and other health providers in the area, the network could be used for providing education. The network members hope that the experience with receiving education via video teleconferencing might increase the number of telemedicine referrals by the same groups of practitioners. The use of the network for education can also provide a potential source of revenue for the network, as well as a recruitment and retention tool for the area. Grigsby et al points out, "Expanded continuing education is often seen as a pre-requisite for attracting and retaining professional staff." [5] This goal of retention and recruitment through enhanced educational opportunities fits well with the overall goals of the Rappahannock Area Health Education Center (RAHEC) (http://www.rahec.net/RAHEC%20Site.htm), the newest member of the network.

NETWORK FORMATION

When the original plan did not receive the expected funding, leadership of the network changed. By changing the organization of the network group to include the RAHEC as the organizing agency, the network becomes a "from here". RAHEC is a known support agency in the area. Their staff are from the community, and they have a history of working to improve the healthcare of the Three Rivers area. Under the leadership of the RAHEC, and based on the assessed needs, Three Rivers Telehealth Network continues to have two purposes, to provide consultative specialty care via telemedicine to the residents of Three Rivers Health District, and to provide educational opportunities to the health practitioners in the area as well as community

members. Two community hospitals, both under 100 beds, a community health center and public health clinic (combined), an Area Health Education Center (AHEC) along with an urban academic medical center have all joined together to form this network. During the year spent preparing to initiate the Three Rivers Telehealth Network, the VCUHS telemedicine coordinator met with several groups, including physicians, to listen to their specific needs for both inpatient and outpatient specialty consultations, such as dermatology, neurology, infectious disease, endocrinology and rheumatology.

Since most medical schools do not include telemedicine in their curriculum, many of the physicians in the rural community were not aware of the numerous opportunities offered through a telehealth network. The telemedicine coordinator was also able to share with the rural physicians the subspecialties available from VCUHS, which are especially amenable to care provided over telemedicine. New reimbursement opportunities were explained, which was well received by the physician groups. Each rural health care facility has identified a medical champion and an administrative champion for telemedicine. As the time has passed, these champions have become even more important in sustaining enthusiasm for the project. Dr. Puskin stresses the importance of the clinical champion, "Minimally, there must be clinical leadership or these systems are doomed to failure, since it is practitioners who drive telemedicine use."[6] Mascovice agrees, "If the major purpose of the network activity is service integration, the rural physician group practice, rather than the hospital, may be the main coordinating element."[7] An administrative champion is also needed to help with resource management at the rural sites during the operationalization phase of the project. These champions have a vested interest in the success of the network, as they have invested time and promised in-kind donations to ensure its

long-term success. The administrative champion at one facility has found funding to replace worn out equipment when the grant did not receive funding.

Keeping the goal of improving the health of the community in mind, the Three Rivers Telehealth Network was especially sensitive to the issues of keeping a safety net in place for the members of the Three River Community. In the rural community, where recruitment and retention is especially difficult, it is vital to comprehend the importance of forming a network, when pursuing a telemedicine project WITHOUT forming a network, would result in competition with local providers for patients, especially those who have insurance. If the network takes the paying patients from the local safety-net providers, but does not provide care for the uninsured, the safety net collapses. It follows that the network will not thrive in the area, as long as there is a choice of provider by the local insurer.[8] It is just as vital to promote the perception of the local hospitals. According to Hicks, when a patient is transferred to a larger urban facility, especially if tests are repeated, the confidence in the rural hospital is decreased, which can result in the patient bypassing the local hospital and go straight to the urban medical center.[4] With telemedicine, the local hospital can provide a more advanced assessment, which increases confidence from the local patients, potentially avoiding loss of patient revenue to the academic medical center. For example, currently the hospitalist from the rural facility calls a VCUHS physician on the phone for consultations. With telemedicine the consult is billable, and the patient is actually seen by a VCUHS specialist. Patients and families can be reassured that even if the patient stays in the community hospital, they are receiving the same care as if they had been transferred to the VCUHS. Hicks goes on to point out that network development is one way to redefine the rural

hospital for survival in the managed care environment, by providing more services through telemedicine links.[4]

Understanding the motivation of a rural health care provider to join a network and identifying the benefits they are expecting are important steps in forming network relationships. Retention of network members will be easier if expectations are made clear from the beginning of the relationship. Moscovice et al lists three motivations for forming networks in rural areas. A "resource dependence model" assumes that during a time of financial uncertainty, it is beneficial to reduce dependence on one source outside the organization. Control of the environment, then, is one motivation to join a network. A second model assumes a reduction in transaction costs, or "the costs of running the economic system". The third model holds that the belief that networks improve access and quality of health care is widespread, therefore communities expect health care providers to collaborate.[7]

The Three Rivers Telehealth Network formed for many of the reasons stated in the literature. By enabling the physicians to link to sources of education and clinical care outside their immediate geographic area, they reduce dependence on an already short supply of physicians. By joining the network together in a distributed model, we utilize economies of scale, increasing the numbers of visits, decreasing the per unit cost of each visit. The network will also potentially increase income to physicians and facilities within the connected areas by increasing the number of patient's seen who would not have been able to be transported, but can be seen on telemedicine. The network formation will also increase expectations of health care providers to collaborate as individuals and physicians see successful consultation outcomes. The standard of

care becomes utilization of the network. Each of the members will contribute to and receive benefits from the network. Each member has clearly stated that the goal of the network is to see an improvement in the health of the population it serves.

Referring back to the model of the onion layers, the third layer, Change Management, was considered in the plans. Forming a successful rural health network also involves acceptance of change, a difficult concept for some rural communities. In order for this change to be accepted by the rural community members, they must "feel ownership for the project". [6] Mueller et al lists three main ingredients to mold change in a rural community: resources, leadership and community capacity.[8] When the Three Rivers Telehealth Network was created, the planning team took into account that resources to provide care via telemedicine would have to be provided, and applied for a Federal grant to purchase needed equipment, pay for consultations for uninsured, help with telecommunications cost, and support salaries to create and sustain the infrastructure of the network. Now, without funding, the network is still successful. With funding the network will be even more useful, so RAHEC and others are seeking funding from several sources.

Local leadership is the second ingredient mentioned by Mueller. When requesting feedback from the community about the network idea, one county administrator was present, additionally, the Three Rivers Health District Health Director has been a key player in the planning of the network. The third ingredient is community capacity. Mueller suggests looking to Medicare and Medicaid for incentives to increase capacity. Since reimbursement is always a question when the idea is presented, the network members are well versed in Medicare and Medicaid policy

regarding reimbursement for telemedicine from the rural areas. This will provide incentive for the involved urban and rural physicians alike. Capacity in the realm of available inpatient bed space has also been an issue. The VCUHS is frequently full and "on diversion". With the telemedicine network, and trusting relationships built between providers, the patients who would have been transferred can be cared for in the community hospital. This benefits the community, by increasing local revenue, the payer, by avoiding transportation and the family who can remain close to the patient.

RESULTS

Success of the Three Rivers Telehealth Network can be measured by the enthusiastic support for the network from the members and their parent organizations. Support was sought and received from each of the network sites in the area. One of the local hospitals has decided to purchase new equipment for the telemedicine project. Seeking the expertise of the network members has proven helpful to this hospital's information department. The testing of current equipment has begun, with donated time and effort from involved sites. Presentations to community members, including potential users in three counties, as well as local physicians were well received. Overcoming the barriers of working in a rural community has begun by gaining the acceptance of the physicians and patients, both potential users of the network.

FUTURE

The Three Rivers Telehealth Network is just beginning to scratch the surface of the wealth of opportunities for improving the health of the Three Rivers population. For example, the network will be able to take advantage of economies of scale as it grows to include other providers in the area. Defining the relationships between the network members is an important first step in creating the network as its own entity. The options for defining relationships in a network vary

from ownership to informal ties between care providers. Moscovice defines "an integrated rural health network as 'a formal organizational arrangement among rural health care providers (and possibly insurers and social service providers) that uses the resources of more than one existing organization and specifies the objectives and methods by which various collaborative functions will be achieved.'"[7]

In order to clarify the relationship between network members in the Three Rivers Telehealth Network, every member has signed a Memorandum of Understanding (MOU). This helps each member solidify his or her commitment to seeing the network succeed. The health care providers in the area include two hospitals owned by a corporation, one privately owned hospital, several private physician offices and county health departments. The members have no interest in establishing relationships which involve vertical or horizontal integration, but will continue in this symbiotic relationship, "supporting each other in the provision of their services and help each other to achieve joint competitive advantage."[7] The strategic advantage for each network member, enhanced by the telehealth links include an increase in the referral base for each facility, revenue incentives including facility fees for providing consultation presentation, and enhanced recruitment and retention for health care providers through increased educational opportunities.

The organizational structure of this network does not fit into Luke's, et al, description of a quasi firm. The survival of each member is not dependent on the survival of the network. The importance of the network to the strategic plans of each participant does not qualify this as a quasi-firm, as defined by Luke, et al. The intended permanence of the network, however is

important. This network has a potential plan for growth and permanence. In the future the network may move from the network classification to a tighter coupling and higher degree of strategic importance to its members.[9]

As a network matures, the relationships between the members will change. The goal of the members is for the Three Rivers Telehealth Network to become its own entity. At a recent gathering, the group decided to form a charter. The members agree it will be necessary to support the infrastructure by contributing financially to sustain the network's infrastructure. Moscovice and Hicks remind us that the operation of a rural health network takes time and dedication to succeed. Human nature looks to each idea for "what's in it for me?" Since members of a distributed network will financially benefit both directly and indirectly, the incentive to participate in care via telemedicine, and thus reap the financial rewards is greater.

The goals of the Three Rivers Telehealth Network include continuous assessment. The initial plan was developed based on needs assessed from the potential network users. "Ongoing assessment of rural practitioner needs by the specialty centers and their rural partners must be built into the management of telemedicine systems for them to be successful."[6] There are more people who are already expressing a desire to be part of the network. As needs are assessed, the network members will continue to look for ways to incorporate others into the network. As Dr. Puskin so aptly summarizes, "Telemedicine is a tool to break down barriers to patient care and professional education. It is the highway of the 21st century by which we are moving information, not patients. Community needs and health care requirements-not technology-should drive telemedicine system development." [6]

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A comparative study of the diffusion of Computerized Health Records among General Practitioners in Australia and Sweden

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What is health, health informatics, e-health and how do they all fit together?

Health is a complex social phenomenon. Health is not just about medicine or the practice of medical methods by doctors. Health is much broader than just medicine, inextricably related to political, economic, legal, environmental and social issues through time. Evidence of this argument is provided by the World Health Organization's (WHO) definition of health:

> ... a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity, is a fundamental human right and that the attainment of the highest possible level of health is a most important world-wide social goal whose realisation requires *action of many social and economic sectors in addition to the health sector*. [1]

From the outset, this implies a broader approach to the study of health which goes beyond traditional disciplinary boundaries. Health is not the exclusive domain of medical practitioners. Thus, it is argued that health informatics, which is defined as "... an umbrella term used to encompass the rapidly evolving discipline of using computers, networking and communications – methodology and technology – to support health related fields ..." [2] rather than medical informatics. Health informatics is more reflective of an approach which tries to embrace a

multidisciplinary approach to the study of health care provision. This is not to deny the importance of medical clinicians, however health needs to be viewed as a partnership made up of network alliances involving many actors. The following definition of primary health care has been adopted:

> primary care is the provision of integrated, accessible health care services by clinicians who are accountable for addressing a large majority of personal health care needs, developing sustained partnership with patients, and practicing in the context of family and community. [3]

The term e-health has also emerged more recently as another umbrella descriptor which attempts to portray the convergence, collaboration and alliance building between numerous actors and disciplines; this book being an example of this idea. Telemedicine is seen to play a significant role in future e-health activities, despite its poor utilization to date [4]. The WHO in their 1993 report indicated the importance of telemedicine at a global level [5]. However, research into the utilization of Computerised Health Records (CHRs) among General Practitioners (GPs) is seen as a critical area of study in an emerging e-health vision. The term GP as used hereafter can be used interchangeably with the terms family practitioner/physician as is the practice of the World Organisation of Family Doctors [6].

Dickinson indicates that in Australia, 80 to 85% of the population will visit their GP within any given year [7]. GPs can be considered as the main point of entry to primary health care in most health systems around the world and therefore GPs can be seen as the gatekeepers of health information, both locally and nationally [8]. This health information is presently an under-utilized information resource in Australia and is generally buried away in hand written files stored in various isolated paper card file

systems at disparate GP sites. General Practice in Australia has been described as a black hole, "so big and impenetrable is this black hole that those charged with the job of analyzing the nation's health needs at a grassroots level are practically working in the dark." [9]. The cost of health care in Australia (GP visits, prescriptions, pathology tests, radiology and specialist visits) was estimated at approximately $7.5 billion (Australian dollars) and the problem of trying to collect some structured information about these events is further exacerbated by the low levels of computer use by GPs [9].

The use of CHRs in General Practice could lead to new processes and ways of looking at health care, for example: epidemiological research; analysis and tracking of disease trends by database queries and data mining; prescription pattern monitoring; calculation of patient and health treatment costs; and providing greater scope for teleconsultations and telemedicine. The central argument is that CHR systems are seen as a fundamental building block for primary health care globally. In order for grander visions of global telemedicine, virtual hospitals and e-health to take place, CHR adoption and use among GPs is therefore seen as a key linking element and needs to be explored. This work explores the discrepancies in the utilization of CHRs, specifically, how can high and low rates of CHR adoption among GPs in different countries be explained? All too often in the medical informatics literature, there is a preponderance of technical or black box studies of CHRs, technics. This is not to say that technical approaches are not informative but they need to be balanced with approaches which give CHRs a wider social and political context of understanding as to why some technologies may or may not be adopted. The process of technology design, i.e. why has a technology been designed in a particular way as opposed to

another design is inextricably linked to the alliances and actors involved in technology construction.

The meaning of health is to a large extent a reflection upon the (de)constructions made by GPs through patient health care records over time, for example, identification of novel types of diseases, classification of diseases, disease trends, etc. It can be argued that what happens at the micro level within GP practices is the basis for shaping macro level national health policy developments, allocation of resources and identification of priority care needs. Macro level health policy in turn shapes micro level GP activities, for example, availability of funds and grants for priority research areas. Information technology can be designed and used to aid this policy process, for it is the information and how it is captured and made available to others that is the central element in the technology design debate. Privacy concerns can be seen as a manifestation of technology design debates [10-12].

Historically, the patient record has been the documentational building block for health care and medical practice as is often traditionally attributed to Hippocrates 5 B.C. The patient health record as such can be considered as a minimum documentational practice. This minimum standard is set by governments through legislation such as Health and Health Services Acts thus, making the record a legal document created by health care workers during the provision of health care to a patient. Traditionally, these have been centered upon a paper-based paradigm of health care, despite patchwork revisions to legislations designed to be more reflective of contemporary technological changes. Computerization of the patient record is an attempt to move from a paper-based paradigm of health care provision to a computerized or electronic

based paradigm. This fundamental change is not without problems and consequences. Linnarsson indicates that the computerization of the patient record needs to be seen as much more than just the simple automation of a manual process [13]. The process of change has many legal, political, health, economic, organizational, technical and social implications and barriers. This is demonstrated in the work of Berg, who examined the rationalization of medical work practices [14]. This is a major change in the organization of how health care is practiced, divisions of labor, funding mechanisms and the way organizations operate; hospitals and GP practices being examples of such organizational structures. CHRs are representative of information systems that allow greater control over patient and practice information and respectively greater accountability and evaluation [15].

What is a Computerised Health Records (CHR) system?

Various authors have looked at the potential role of computers in medical practice over the decades [16-21]. The actual meaning of CHRs is however reflective of a social and political process through time, (de)constructed by actors who have an interest or stakehold in CHRs. Hence, conceptually, the patient record should be considered as a socially constructed technology which exists within a larger system of health technologies, networks and actors. For this reason various individuals and organizations have attempted to define and shape the debate over CHRs. A key organizational actor has been the Institute of Medicine (IOM) in the United States of America [22, 23]. The IOM defines the Computer-Based Patient Record in the following way:

> an electronic patient record that resides in a system specifically designed to support users by providing accessibility to complete and accurate data, alerts, reminders, clinical decision support systems, links to medical knowledge, and other aids. [22]

This definition is a rather ambitious, broadly ranging ideal. It does not necessarily exist in practice, despite systems which may try to approximate this ideal. There is also a tendency to focus on clinical systems rather than on a more holistic organizational or practice management system which also includes non-clinical components such as accounting and budget management. This will come under the spotlight more so in coming years especially in health care systems where GPs operate, or may be encouraged to operate, as private business entities rather than government funded employees.

The significance of information and telecommunications systems within health care cannot be denied. In the USA, Schneider et al argue that telemedicine could save billions of dollars by using the telecommunications system to exchange health information between providers [24]. In Australia, the telemedicine vision can be characterized by a growing number of pilot and experimental projects [25-28]. Pradhan provides a useful account of the area and some of the issues [29].

Theoretical Background for Understanding Actors, Networks and alliances in e-health

Market competition can be interpreted as organizational politics and the battle over the control of economic modes of production and information markets with the health

sector being one such market [30, 31]. Hence, CHRs can also be explained as a development within a more competitive market framework; information as a commodity which gives competitive economic advantage and reduces uncertainty [32-38]. Therefore, (information) technology studies are reflective of theories for understanding the organization and control of market and social structure [39-43]. E-health is therefore an extension of competitive thinking in health care.

Rigby indicates:

> "Healthcare organizational structures are frequently seen as a hierarchy of networks and alliances. The individual healthcare organization has a network relationship to other health care organizations. Additionally, there will be alliances with related organizations. Internally, the health organization can be viewed as a network of departments or clinicians liaising directly with one another …" [44]

E-health organizations in the future may be defined more by their telecommunications networks rather than just their physical presence. The idea of "frames of meaning" is essentially derived from Collins and Pinch [45] and Bijker et al. [40] who use the term "technological frame" to represent "… the *interaction* of various actors …". Hence, as used here, this frame is representative of the negotiation space or (de)construction space, of meaning between actors and actor networks in different discipline frames. This builds upon the idea of actor networks within different meaning frames [40, 46]. For example, GPs are essentially actors in organizational, professional and social networks, formal and informal e.g. the general practice setting; or professional bodies like the Australian Medical Association (AMA), the Royal Australian College of General Practitioners (RACGP), the Australian College of Health Informatics

(ACHI), and the Health Informatics Society of Australia (HISA). All attempt to shape the meaning and artifactual form of patient records with other actors both within meaning frames and between actors within other professional networks e.g. government administrators, policy planners, strategists, third party insurers, patients, nurses, pathologists, pharmacists, radiologists, CHR vendors, software standards bodies, and others. Conflict is therefore inherent in this negotiation of meanings and artifact translation process. This creative disruption is perceived as benefiting some professional groups of actors more than others, and as a possible destabilization of the status quo. Some perceive a possible gain in power over other actors while some perceive a loss in power, restructuring, hence the utility of a socio-political paradigm of understanding CHR diffusion and non-diffusion. Technical black box design, translation and diffusion are a socio-political process among various actors and needs to be understood as such.

CHRs need to be viewed as an organizational construct. At a theoretical level, the question then arises as to whether actors can also be inanimate objects such as software programs like computerized health records systems. CHRs should be considered as actors as they embody inherent political and social ideals about how GPs should organize their health/medical thinking and work behavior, directly and indirectly by way of the design. A software standard (e.g. HL7) may be embodied by a CHR program and therefore reflects a set of particular values as espoused by other actors in professional networks (for example standards organizations such as the European Standards Organisation (CEN), ANSI, IEEE, ISO, ITU). Along similar lines, decisions about the type of organizational schema to be used to structure a patient record, for example Weed's problem oriented record [47] and the medical

nomenclature to be used for diagnosis (e.g. SNOMED, ICD-10, Read). These all reflect attempts to structure not only the GP-patient consultation but also promote a particular way of thinking. Hence, the technology is symbolic of the embodiment of these ideals and not just a neutral tool to be used, CHRs are actors themselves since they influence work behavior in a particular direction. It must be acknowledged that CHRs may be put to uses never envisioned by actors at the design stage and this should be seen as the creativity or novelty process of re-invention and change over time. Thus, the deconstruction of what CHRs mean also occurs in order to reflect changes in thinking about health care systems and to reposition the value of CHRs accordingly in a global e-health environment. It may well be argued that CHRs are both a threat and an opportunity for GPs to either increase or decrease their personal and professional self interest both individually and as a profession. This will be a reflection upon how GPs, individually or collectively, shape the debate over CHRs. The outcome of this is still hard to predict as some actors are more vigilant and powerful than others in looking after their own self interest. More interesting is the interaction that takes place among actors, especially when those actors cross-disciplinary and market boundaries as a result of converging interests and motivations. From an actor network point of view the crossing of market boundaries represents a communication interaction and information exchange between actors from different networks, and a gradual convergence or closer integration of various actor networks in a global e-health system.

The classic work of Luke et al. provides a useful framework of thinking about quasi firms and how a wide variety of loosely coupled inter-organizational arrangements can be designed to achieve strategic objectives in health care [48]. The authors

attempted to classify quasi firms, how they can be created and mechanisms for strategic decision-making. The table below extends the research agenda offered by Luke et al. and provides a perspective on how network alliances may further develop and the types of impacts they may have:

Organisation identity	**Information enablement**	**Effects**
Internal departmental unit	Expert knowledge bases; telecommunications	Departments work to external standards; can "trade" widely
Local alliances	Local area networks, etc.	"Virtual" organization, but no overall control
Global and national trading	Telemedicine and Internet	Bigger business, but unresolved control and accountability issues

Source: Rigby [44]

The International Medical Informatics Association (IMIA) can be seen as an international alliance of actors pursuing various health informatics agendas. IMIA was initially established in 1978 as a special interest group of The International Federation for Information Processing until 1989 when it gained status in its own right. It has many national and corresponding institutional members and links to the WHO. Figure 1 below is a simple overview of the linkages between various organizational actors and their relationship to each other.

(Insert Figure 1)

New networks (or the realignment of existing networks) and organizational alliances are forming all the time in e-health as governments and patients have greater expectations over how computer technology and telecommunications can be utilized, for example, use of the WWW. Consumer health informatics is reflective of this thinking [49-52].

CHRs in a diffusion context

Through the work of Rogers we can begin to think about *what* happens, the rate of diffusion (as depicted by the S-shaped curve) and *why* the rate of diffusion may vary in different settings but not always *how* the process of diffusion actually happens [53]. Rogers provides a useful framework of analysis such as the perceived attributes of innovations (relative advantage, compatibility, complexity, observability and trialability); type of innovation decision (optional, collective, authority); communication channels (e.g. mass media or interpersonal); nature of the social system (e.g., its norms, degree of network interconnectedness, etc.); and the extent of change agents' promotion efforts [53].

It would be somewhat optimistic, given current knowledge about information systems failure [54], to think that there exists a general unifying pattern of diffusion which serves to explain *what* happens, *how* it happens and *why* for all cases. There will be

varying rates of diffusion between individuals, within organizations and national systems. For example, in studies of military e-health systems, well designed formal bureaucratic structures were not sufficient to insure acceptable utilization rates of e-health technologies, research yielded that organizational and cultural dimensions related to uncertainty avoidance and may explain some variance in utilization rates [4]. Therefore, cross-national studies are useful for helping to identify the reasons for utilization variance. Straub also looked at the effect culture has on diffusion by examining the diffusion of e-mail and fax in Japan and the USA [55]. Furthermore, Geffen and Straub looked at gender differences in the utilization of e-mail using a cross sectional survey instrument [56]. They argued that gender needs to be added to an IT diffusion model since gender differences may be related to beliefs and use of computer-based media. The findings indicated that men and women differ in their perceptions but not in the use of e-mail. This work adds to the Technology Acceptance Model (TAM) proposed by Davis et al., (1989) which is essentially a causal model trying to correlate system use with perceived ease of use and perceived usefulness. The origins of this model can further be traced back to the Theory of Reasoned Action by Ajzen and Fishbein [57]. Another approach is offered by Heikkilä who argues that "... the willingness to adopt is more dependent on the adopter-technology fit, and the sustained use is more dependent on the task-technology fit", possibly with peers serving as a moderating reference group [58]. This also points to learning processes as being vital to sustained utilization as advocated by several authors [59, 60]. Kidd et al also argue that the learning process is incremental and full utilization of CHRs takes time [61]. Rogers argues that information exposure is the most important explanation for diffusion [53]. Valente takes this one step further and argues that exposure (contagion) is not enough but

rather that the focus needs to be on the frequency of exposure [62]. The more a person is exposed to an idea or technology the greater likelihood there is that utilization at some level may take place. But this is not to deny that it may also serve to reinforce an individual's decision to reject the idea.

Past studies of Electronic Data Interchange (EDI) are also informative, Emmelhainz argued that organizations with low utilization and knowledge of EDI tended to postpone EDI adoption until there was only one type of standard in the industry [63]. This may also be the case with CHRs and needs to be investigated further. A Swedish survey conducted in 1994 identified 27 different suppliers of CHRs of which only a few were deemed able to meet reasonable user requirements [64, 65]. Finally, in a market environment, competition between GPs may lead to greater utilization rates of CHRs as those GPs who adopt and learn to use CHRs strategically may squeeze non-users out of the market place. This interpretation is more reflective of a competitive advantage way of thinking [32, 33, 66, 67].

GP computer utilization

It would appear that a great number of discussion papers, reports, and studies have been published since 1991 in Australia. The main impetus for this sudden movement would appear to be a series of overseas events, primarily the work of the IOM and their landmark study into the computer-based patient record. The only publication work of any significance in this context before this time in Australia were the RACGP study (1985) and the CAPP (1986-1990) project [68, 69]. These spawned the work of O'Toole, Crampton and Lord and the Crampton RACGP Survey [70-72]. It must be

noted that, despite chronological appearances, some of the work may have been stimulated by events in the USA prior to publication of the IOM's report in 1991. This also needs to be seen in the broader context of initiatives which took place in the U.K and Europe such as the work of IFIP and IMIA and, prior to the work of the IOM, the work of Greisser et al. on data protection in health information systems [73]. Another significant initiative was the UK Government's "micros for GPs" scheme, established in 1972, which, after a long gestation period, received an injection from the government of 24 million pounds in 1989, to allow GPs to purchase computers and software [70, 74]. Tied into this initiative was the Government supported development of Read Codes [75], to try and structure the clinical input of medical terms used by GPs in their computer systems to allow analysis of clinical data, (un)aggregated, so as to help in health service planning, epidemiological research and auditing.

The RACGP (1985) study revealed that 54% of the RACGP respondents viewed computers as having some potential to improve practice management but not clinical records [68]. Only 19% agreed that computerizing patient records would improve the quality of patient care and only 14% supported the sharing of information among other health care actors. Also of interest was that only 20% of RACGP respondents agreed that patients had a right to see their entire record.

O'Toole provides an initial attempt to document the field of medical record computing in Australia from a GP's point of view [70]. O'Toole argues that the generalist practitioner of the 1980s faces a situation of growing information overload relative to practitioners in previous periods. This tension is characterized as the

generalist-specialist dichotomy with ever increasing levels of specialization and the fragmentation of knowledge. One attempt to try and deal with this information processing dilemma is through the use of computer technology. O'Toole optimistically argues that the computer is the answer to these problems.

The Computer Assisted Practice Project (CAPP) represents one of the largest attempts to explore computer implementation and use issues in General Practice Australia [69]. It is from this study that a number of various spin-offs continue to have relevance even to the present day, e.g. computerized prescribing, computer age/sex/disease registers, computerized drug databases, attitude surveys, coding and standards issues. Conducted over a five-year period (1986-1990) the CAPP study primarily consisted of a number of sub-projects. In essence, 22 general practices across Australia were evaluated for their use of a practice computer system, (*Medrecord*), and their opinions and experiences were analyzed using both qualitative and quantitative methods. The project showed that computerized accounting and medical records achieved a high level of acceptance among doctors, staff and patients. This was followed up by a report in 1994 by the RACGP which extended the project timeline (1986-1993) and focused somewhat more on the usage and problems surrounding computer records. The main problems identified centered around data entry, accidental data loss and presentation.

Also of significance was the national survey of computer use among RACGP members by Crampton [71]. The basic finding was that 41% of GPs used a computer in their general practices for such activities as accounts, billing, word processing, but only 2% used computers for clinical purposes. Younger GPs and those in group

the use of technology leads to actual improved patient health outcomes and how this is measured?

Generally, governments are involved in the management of health care resources, costs, outcomes and equity issues. Nevertheless, these may all be interpreted differently, for example, equity may be seen as the redistribution of health care costs as opposed to accessibility to health care services. Health systems and health policy are often reflective of a complex historical and political mix of changes to the organization of funding arrangements and responsibilities between various levels of government (e.g. national, state and local), for example, the Australian Health Care system. The Australian health care system can be described as reflective of a philosophical position located somewhere between the U.K. National Health Service and the USA health system, with a gradual movement away from government funding and public health insurance to a more privatized system based on individual private health insurance [84, 85].

It would appear that the U.K, the Swedish and Australian health systems share some common features but also have some distinct variations. It becomes evident that the more health systems devolve from a centralized system to a more decentralized regional/local system the more variation and experimentation in budget devolution and patient needs-assessment planning is evident across counties in Sweden, the U.K or across States and GP Divisions in Australia.

The health care system in the U.K. is based on a system of care provided by GPs who can be seen as private contractors paid by the National Health Service, just as GPs in

practices were more likely to use computers. Also, cost had a bearing on the attitudes of GPs towards use of computers.

Other relevant surveys which have looked at various aspects of computerization in General Practice in Australia include the work of Douglas and Saltman, Liaw, Fry, Cacek and Bolton and Gay [76-80]. In the Douglas and Saltman study of 1900 GPs, respondents indicated they used computers mainly for front desk type applications such as accounts (34%) or word-processing (33%) while only 5% used the computer for recording clinical information [76]. Furthermore, many GPs were found to be using traditional, paper based 8" x 5" cards and less than half were using any accredited medical records system at all.

Based on previous studies, it has generally been claimed that the adoption rate of CMRs by GPs in Australia has been low, ranging from 2% to around 8%, with computerization levels to be around 40% [68, 71, 80]. This is in contrast to the U.K. where 50% of primary practitioners use the computer for clinical notes and 90% of primary care practitioners work in computerized practices [81]. As a further comparison, in Singapore, the adoption rate is said to be somewhere between 30-50% [82] and less than 30% in Hong Kong [83]

A brief background to the Australian and Swedish health systems

It must never be forgotten that the critical longer term questions facing e-health researchers are not just how technologies can be designed to help patients but whether

Australia are paid by the Australian Health Insurance System (Medicare). Experimentation with the idea of purchasers and providers is evident in both the U.K and Swedish health care systems where local councils purchase health care services from their regional and national organizing bodies in order to tailor provisions to the specific health care needs of their respective communities. GPs are essentially given a budget to work with in order to try and buy the health services required for their patients. This can be problematic since patient needs will vary, for example, between rural and urban areas. However, problems of definition and classification over what constitutes rural areas serves to add more complexity to the problem, especially since government funding formulas are tied into such definitions [86]. Casemix and DRGs can be seen as a manifestation of this attempted tailoring process at the hospital level.

The Swedish Health Care system, makes use of a patient registration list system by which a list of patients (about 2000/GP, variations do occur) is assigned to each district GP. The Swedish system has experimented (1994/95) with the house doctor system (a patient can choose which GP they wished to belong to) but with only mixed success in that some GPs had excessive lists while others had diminishing list numbers. Some counties have adopted the system (e.g. Uppsala) while others have reverted back to the old district doctor list system.

The U.K and Swedish systems can be characterized as systems in a state of continuing flux [87, 88]; similarly the Australian system is one facing mounting economic pressure to change. The cost of the publicly funded Medicare System in Australia is rapidly escalating well over $7.5 billion [9]. This can be seen as a problem arising from an over- supply of GPs leading to over-servicing and outright rorting of the

system by some GPs. As indicated, this problem is escalating as more medical doctors are pumped out of educational institutions every year leading to a mismatch between supply and demand. This over-supply of GPs places more of an economic burden on the National Medicare health bill that taxpayers eventually have to help fund (through a levy on taxable income) since more medical doctors equates to greater consumption of various medical services. Hence, both GP over-servicing behavior and supply need to be constantly monitored [89]. This would suggest some form of direct regulatory strategy from the Government. There is predominantly an imbalance between rural and city areas in that there is an over-supply of GPs in large city areas and an under-supply in smaller rural regions [90].

Historically, rural areas in Australia have been disadvantaged in terms of access to health services [91, 92]. This stems in part to the fact that political, legislative and economic power in Australia is generally located in the National and State capitals rather than at the Local government levels. Thus, health budget devolution to local government can be viewed as an attempt to try and re-address part of this power imbalance. Financial responsibility is shifted over to local government, but this does not necessarily address the need for more revenue to fund increasing demand for health care services.

Good health and equal access to health services for everyone are the goals of both the Australian and Swedish health care systems as articulated through national policy and a range of legislations including the National Health Act, the Health Insurance Act and the Medicare Levy Act in Australia and the Health and Medical Services Act in Sweden. A fundamental principle of both systems is public sector responsibility to

provide and finance health services for the entire population. In Sweden health is organized in a decentralized way through bodies called Landstinget which are situated in each of the twenty-five Counties. The responsibility and operational management for health care services rests primarily with the local County Councils who have the power to levy taxes to raise the finances required to run these services. This is a reflection of the Swedish Welfare State ideology and also a reason for the generally high tax regime used to fund social services. The Australian Health Care system is administered by the Federal Government in conjunction with the respective State Governments and Area Health Services (who are responsible for public hospitals) through funding grants and the Medicare Levy. The history of Australian welfare programs has been one of targeted welfare rather than universal social programs as in Sweden. Hence, GPs in Sweden operate mainly under a public umbrella health care system funded by the County Councils while GPs in Australia mainly operate as private businesses within a public system. They thus receive minimal direct financial assistance with CMRs, however the Practice Incentives Program is an attempt to readdress this issue.

Questionnaire Design

Field visits and interviews were conducted with GPs both in Australia and Sweden in order to help with the identification of the issues to be investigated. The questionnaire itself went through several drafts and pilot testing for face validity before distribution. Responses were sought for questions relating to demographic data, educational background and training, computer use/non-use, adoption barriers, computer security awareness, software/hardware platforms as well as present and possible future trends

in the use of CHRs. The questionnaire comprised of a common section for all respondents and then two nested sections, one for GPs who were CHR users and another for those who were non-computerized. Both open ended and closed questions were included where appropriate. The design of the questionnaire included a coding schema for easier transcription into a spreadsheet and imported subsequently into SPSS for data analysis. All mail out questionnaires were accompanied by covering letters and prepaid return address envelopes. The questionnaire was developed in English and Swedish.

Sample Selection

Sample selection can take various forms, random, non-random or some quasi combination of the two. A random sample of GPs was chosen as being an appropriate approach based on the experience of other researchers in the area [21, 71, 79, 80].

The Swedish GP sample and mailing list was made available courtesy of the Department of Family Medicine, Uppsala University. The survey was sent to a random computer generated sample of GPs in Sweden (N=600). The first and only mailing was conducted in November 1994 for return before mid December. A 50% (n=298) response rate was gained and there were no follow up or reminder notices to increase the response rate.

The Australian mailing list was made available courtesy of the Commonwealth Department of Human Services and Health. A random computer-generated sample was provided and the state of New South Wales was also randomly chosen for

sampling (N=600). The first and only mailing was carried out in November 1995 for return before mid-December. A 49% (n=293) response rate was gained and there were no follow-up or reminder notices to increase this rate. The respective samples were deemed to be representative of their respective GP populations based on national data.

Survey findings

The main findings of the survey conducted indicate that there has been a high rate (72%) of diffusion of computers and CMRs among GPs in Sweden and a low rate (14%) of diffusion among GPs in Australia. Moreover, use of computers by Australian GPs is still predominantly confined to front desk type applications (e.g. accounts/billing, word processing) as opposed to clinical CMR use (e.g. patient notes, script writing, recall and referral, test ordering). On further analysis, only 16% of the Australian computer user respondents (14% overall) indicated that their main computer use was for patient records as opposed to 93% of the 72% of Swedish respondents. This means that of the 14% of Australian respondents who do use computers only 2% use them specifically for clinical purposes while the rest of the 12% make some use of CMRs but it was not considered to be their main use. This supports the more general findings of the survey work conducted by Cacek who found that of the 35% of Australian GPs using a computer, 78% were using computers for word processing and 63% for financial management [79].

Findings further indicate that the high rate of diffusion in Sweden has mainly been achieved by direct financial funding schemes from the Swedish Government and County Councils. Furthermore, 80% of the Swedish respondents indicated a strong

belief that CMRs will be an essential technology for health care in the future as compared to only 55% of Australian respondents.

Among GPs who are CMR users, results from both samples support the claim that CMRs are helping to improve the way GPs work (Australia 82% and Sweden 69%) but the consensus is less than overwhelming. Both samples indicated improvements in the following areas: having increased quality control over patient information (as opposed to hand-written notes); faster access to patient records; and easier access to patient information when dealing with telephone enquiries. These can be considered as relative advantage attributes of CMRs [53], or even long-term economic advantages, due to savings in time, effort and organization (whether of information or staff). Overall, 92% of Australian respondents still process patient records manually while 95% of the Swedish respondents process records electronically using a computer. Only one respondent in Sweden indicated keeping hand-written patient records. Table 1 provides a comparative view of beliefs and adoption rates.

Table 1. Beliefs and CMR adoption rates

	AUSTRALIA (NSW) N=293			SWEDEN N=298		
	Total	Males	Females	Total	Males	Females
GPs who believe CMRs are an essential technology for health care in the future	55% (n=158)	73% (n=115)	27% (n=43)	80% (n=236)	61% (n=144)	39% (n=92)
Total responses Missing	286 7			294 4		
GPs who use CMRs	14% (n=42)	90.5% (n=38)	9.5% (n=43)	72% (n=215)	57% (n=123)	43% (n=42)
Total responses Missing	292 1			298 0		
GP CMR users who believe CMRs have improved work practices	82% (n=36)	94% (n=34)	6% (n=2)	69% (n=140)	59% (n=83)	41% (n=57)
Total responses Missing	44 249			204 94		

Statistical testing indicated significance at the .05 level for cross-tabulation of GPs who use CMRs and gender in the Australian sample, as can be seen in Table 2. This is the only response which supports the hypothesis that a relation exists between gender and CMR use. Nevertheless, no such relation was found in the Swedish sample. Furthermore, no other correlations between belief about CMRs and gender were found to be significant in either sample.

Table 2. Tests of significance for GP CMR use and gender

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.366[b]	1	.004		
Continuity Correction[a]	7.327	1	.007		
Likelihood Ratio	9.974	1	.002		
Fisher's Exact Test				.003	.002
Linear-by-Linear Association	8.337	1	.004		
N of Valid Cases	292				

a. Computed only for a 2x2 table

b. 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.79.

There are also similarities between the makeup of GPs in both the Swedish and Australian samples, especially in relation to employment status, 77% of respondents in both samples regard themselves as being employed full time and 23% of respondents regard themselves as being employed part time. The male to female ratio in Australia was 72:28 while the Swedish ratio was 60:40. Hence, GPs tend to be male, employed full time and are aged in their mid-forties (Australia: mean = 45 years, standard deviation = 5.6 years; Sweden: mean = 46 years, standard deviation = 10.5 years). In Sweden GPs tend to cluster to form group practices more than in Australia (Sweden, mean = 5, s.d. = 2; Australia, mean = 3, s.d. = 2) where GPs predominantly operate more in solo or partnership practice. In fact 50% of the respondents in Australia operated in practices with three or less members. The most obvious difference between the two samples is in the type of practices. In Sweden 92% of GP respondents are predominantly in public practice while 95% of GP respondents in Australia are in private practice. Furthermore, the numbers of staff employed per practice was significantly higher in Sweden (mean = 18, s.d. = 13) than in Australia (mean = 5, s.d. = 5), which is reflective of the larger public service and

pro-government employment policies in Sweden versus cost-controlled and profit-oriented operations in Australia.

The claim that in both Australia and Sweden the trend is towards the clustering of GPs with other allied practitioners (for example, dentists) in one center or practice [93, 94] is also supported by the survey. In Sweden this is seen to aid cooperation and the sharing of medical resources among primary care practitioners while in Australia this move is not merely for cooperation but more importantly to create super clinics which achieve greater economies of scale, throughput and returns. Australian respondents also indicated seeing a lot more patients per week (mean = 132, s.d. =7 3) than GPs in Sweden (mean = 63, s.d. = 19).

The non-computerized samples offer some distinct differences in GP attitudes. In the Australian sample, of the overall non-computerized respondents (86%), 63% believe CMRs will improve the way GPs work but 67% do not plan to implement CMRs within the next 3 years. Follow-up questions indicated that 65% did not feel that they had a problem managing patient health records which may, if answered truthfully, account for why non-computerized GPs felt that they did not need to computerize. A significant number of the Australian GPs are obviously not convinced of the benefits of CMRs over paper records, and 77% indicated that they have taken no planning steps towards implementing CMRs whatsoever. Respondents indicated that they were concerned over lack of software standards and data portability between software systems. There was also some concern over the problem of converting from paper to computer and the time, cost and effort involved in such an endeavor, especially if there was no support involved.

In contrast, 68% of the Swedish non-computerized respondents indicated they were having problems managing patient records and that CMRs were perceived as helping to resolve these problems. Within the Swedish non-computerized sample (28%), 72% believe that CMRs will improve the way GPs work and 90% plan to introduce CMRs within the next three years. Table 3 provides a comparative view of non-computerized attitudes of GPs towards CMRs.

Table 3. Non-Computerised attitudes towards CMRs

	AUSTRALIA (NSW) N=293			SWEDEN N=298		
	Total	Males	Females	Total	Males	Females
Non-computerized respondents	86% (n=250)	69% (n=172)	31% (n=78)	28% (n=83)	68% (n=56)	32% (n=27)
Total responses Missing	292 1			298 0		
Non-computerized respondents who have problems managing patient records	35% (n=93)	73% (n=68)	27% (n=25)	68% (n=56)	68% (n=38)	32% (n=18)
Total responses Missing	268 25			82 216		
Non-computerized respondents who believe CMRs will improve the way GPs work	63% (n=164)	73% (n=119)	27% (n=45)	72% (n=55)	71% (n=39)	29% (n=16)
Total responses Missing	259 34			76 222		
Non-computerized respondents who plan to implement CMRs within the next 3 years	33% (n=82)	72% (n=59)	28% (n=23)	90% (n=71)	66% (n=47)	34% (n=24)
Total responses Missing	246 47			79 219		

In both samples there were some respondents who indicated that they kept no backup records or had no disaster recovery plan for patient records. In the case of keeping backups, Australian respondents (81%) were found to be guiltier of this than Swedish GPs (19%). This is attributable to the fact that Australian GPs are predominantly non-CMR users and do not keep paper-based backup records. Nevertheless, both samples overwhelmingly consider themselves as responsible for the accuracy of patient information contained in patient records. Again, ideological differences become apparent in that of the Australian sample, 95% believe that it is the GP who owns the patient record while 44% of the Swedish respondents believe that the Government owns the patient record. Clearly, GPs feel that they are responsible in some way for

the patient information but interestingly Australian GPs, much more than their Swedish counterparts, do not seem responsible enough in protecting this valuable resource. A legal precedent may yet be set in this area, along with the testing of the validity of CMRs in the courts. Legislation is traditionally based around a paper-based paradigm rather than an electronic one. Only 3% of Australian respondents indicated that they thought the patient owned the information and no respondents thought that the government owned the information. Swedish responses more strongly favored a model of joint ownership of patient information between government, GPs and patients than did the Australian sample. This may be linked to the funding mechanisms for CMRs, since 88% of the Australian respondents indicated receiving no government help with computerization as opposed to 77% of Swedish respondents who did receive financial help to computerize from central and local governments. Table 4 provides a comparative view of general security, responsibility, ownership and support issues among all GPs surveyed.

Table 4. General security, responsibility, ownership and support issues among all GPs

	AUSTRALIA (NSW) N=293			SWEDEN N=298		
	Total	Males	Females	Total	Males	Females
All GPs who keep no backup records	81% (n=226)	71% (n=161)	29% (n=65)	19% (n=54)	65% (n=35)	35% (n=19)
Total responses Missing	279 14			284 14		
All GPs who have no disaster recovery plan	90% (n=158)	75% (n=119)	25% (n=39)	91% (n=32)	72% (n=23)	28% (n=9)
Total responses Missing	176 117			35 263		
All GPs who consider themselves responsible for the accuracy of patient information	98% (n=286)	71% (n=204)	29% (n=82)	99% (n=287)	60% (n=173)	40% (n=114)
Total responses Missing	292 1			291 7		
All GPs who believe they own the patient record	95% (n=275)	72% (n=198)	28% (n=77)	14% (n=37)	62% (n=23)	38% (n=14)
Total responses Missing	289 4			264 34		
All GPs who have received government help with computerization	12% (n=34)	71% (n=24)	29% (n=10)	77% (n=216)	60% (n=130)	40% (n=86)
Total responses Missing	276 17			280 18		

Computer-using respondents indicated having had a wide range of computer experience. Despite the low use of CMRs among respondents in Australia, experience with CMRs was longer (mean = 44 months, s.d. = 41 months) as compared to Sweden (mean = 25 months, s.d. = 23 months).

The general software/hardware trend is towards PC Windows based platforms with software that integrates CMRs with other functions, e.g. accounts/billing, appointments scheduling, word processing, electronic mail, etc. The potential for a

GP Office like software is apparent. In the Australian sample, computers being used solely as stand-alone workstations were as common as those in a multi-user network configuration. In Sweden, however, 97% of respondents had their computers set up in a multi-user network configuration. This is a reflection of the larger staff and GP numbers needing to share computers in a practice. The password remains the most common form of security protection in both samples. Table 5 provides a comparative overview of computerized GPs.

Table 5. Computerised GPs

	AUSTRALIA (NSW) N=293			SWEDEN N=298		
	Total	Males	Females	Total	Males	Females
Computerised GPs who use a coding scheme to classify patient morbidity (e.g. ICD-10, etc)	19% (n=9)	100% (n=9)	0% (n=0)	89% (n=185)	55% (n=101)	45% (n=84)
Total responses Missing	48 245			209 89		
Computerised GPs who follow some type of patient information management guidelines or practice	25% (n=11	100% (n=11)	0% (n=0)	75% (n=147)	58% (n=85)	42% (n=62)
Total responses Missing	44 249			195 103		
Computerised respondents indicating that passwords are their main form of computer security	98% (n=34)	91% (n=31)	9% (n=3)	94% (n=186)	56.5% (n=105)	43.5% (n=81)
Total responses Missing	38 255			198 100		
Computerised GPs who encrypt their patient database	27% (n=11)	82% (n=9)	18% (n=2)	33% (n=51)	61% (n=31)	39% (n=20)
Total responses Missing	41 252			156 142		
Computerised GPs who have outside dial-in access to their patient database	24% (n=10)	90% (n=9)	10% (n=1)	13% (n=216)	69% (n=130)	31% (n=86)
Total responses Missing	42 251			196 102		

Within both samples, very few had to undertake any computer-related subjects as part of their medical education. This may well be attributable to the fact that desktop computers were not around nor as accessible when the majority of respondents were undergoing their medical education (the mean year of medical education completion in the Australian sample was 1974, s.d. = 10 years; and in Sweden 1977, s.d. = 6 years). Nevertheless, this would indicate that there is no predisposition to adopt CMRs by having undertaken computer-related subjects at university and subsequent later CMR adoption. The Swedish results would indicate that high CMR adoption is possible without there necessarily being an association between computer use at university and CMR adoption. In the Swedish case the decision to adopt CMRs is more of a result of direct funding availability (a type of authority decision) from the government, while in Australia the decision to adopt CMRs is more of an individual optional or collective group practice business decision.

The most common sources of information about keeping up to date about computers were through colleagues, journals and conferences. It is interesting to note that journals preceded colleagues in the Australian sample (51%:18%), while in the Swedish sample it was the reverse (26%:48%).

GP respondents in Sweden indicated that the lack of a CMR software standard among GPs was their main barrier to adoption while Australian respondents indicated that cost was the major inhibiting factor. Another barrier to adoption that arises from the qualitative responses is finding the time to transfer over from a paper-based patient

records system to a CMR system, especially the laborious task of having to enter patient information into the system.

Discussion

"It is perhaps easiest to begin by stating what statistics is not. Statistics first of all is not a method by which one can prove almost anything one wants to prove." [95]. Statistical testing and presentation of the data only provides for one level of analysis and reporting. It was important to present the response breakdown by gender since it was hypothesized that men and women perceive CHRs differently, which influences their decision to adopt or not to adopt the technology. The results on this are inconclusive, gender may be an element not just in CHR utilization among GPs but also an attribute that may need to be added to the diffusion model proposed by Rogers [53]. However, as with any analysis, "The best data analysis comes not from keystrokes and printouts, but from spending time thinking." [96].

The high rate of diffusion in Sweden supports the idea that perceived belief about a technology could be an important characteristic in the adoption process, hence a possible extension of the five characteristic model of adoption as proposed by Rogers. Nevertheless, Rogers does capture this thinking in the idea of homophily and heterophily used to describe actors in similar or different social network groupings based on belief, education, social status, etc. Therefore, the relationship between belief and adoption/non-adoption needs to be investigated further. It may well be that belief, above all else, influences an actor to want to adopt. Nevertheless, it may also be the case that there is no generalizable association between belief and actual

adoption since availability of funding may in fact be the key adoption factor, therefore funding availability may need to be added to the adoption model proposed by Rogers.

The clustering of GPs with allied practitioners in Australia could cause over-servicing by GPs, especially under the publicly funded Medicare system. The fact that Australian respondents indicated seeing many more patients per week can be seen as a further reflection of the attitude that primary health care is more of a business. Throughput becomes a measure of financial return, which stands in opposition to that of sharing among public sector GPs in Sweden who have a set list of patients for their area and for each of whom they are paid a set amount from the public purse. Nevertheless, patients more so in Sweden than in Australia, also have to make a co-payment when visiting the GP which may act as a deterrent for patients from seeing a GP. Greater application of compulsory co-payments in the Australian GP scene could be worth investigating but not as another revenue stream for the GP on top of the existing Medicare payment. Instead, the patient co-payment could be used to help pay for the Medicare payment, which in turn would be a contribution to helping to reduce the Australian Medicare bill.

The relatively high level of favorable attitudes but relatively low rate of adoption in Australia is somewhat similar to the "KAP-gap" (Knowledge, Attitudes, Practice) problems of family planning diffusion surveys carried out in Third World countries during the 1960s [53]. This may be due to a combination of a low degree of observability of the long-term benefits and socio-political drawbacks such as gradual loss of ownership, power and control over patient data access. GPs are also reluctant

to computerize because of the fear of choosing software which may become obsolete or may be incompatible with other systems.

In terms of the most common source of information for GPs, in Australia journals preceded colleagues, while the reverse was the case in the Swedish sample. This is significant since, according to the innovation decision process model presented by, mass media awareness is considered to be the main communication channel for creating knowledge awareness. In this model, persuasion to adopt occurs at a more interpersonal level usually after mass media knowledge awareness has taken place. The Australian sample responses would appear to support this model but the results from the Swedish sample suggest that mass media channels do not play such a key role in knowledge awareness and that from the outset, interpersonal communications with colleagues are more significant in the formulation of attitudes. This would also indicate a more collective based decision-making process among the Swedish sample as opposed to a more individualized process in Australia. This is possibly a significant point worthy of follow-up since more respondents in the Swedish sample have adopted CMRs; hence, the innovation-decision process model proposed by Rogers may need to be modified or rejected. Future studies may wish to follow up on this aspect by including another, more specific follow-up question about how respondents found out about CMRs in the first place, rather than just about computer developments (e.g. mass media, interpersonal or other).

In the context of spatial diffusion, another question worth pursuing may be to see if proximity to colleagues plays a role in persuasion to adopt or reject; for example, do the colleagues from whom information was received work within the same practice,

live in the same city, or elsewhere? Furthermore, this implies that word of mouth can be seen as an important form of communication among GPs, possibly more so than mass media communication channels when considering making a decision to adopt or to reject. In Australia, this could be attributable to internalizing something a GP may have read in a journal and then testing that information with colleagues prior to either accepting or rejecting information and ideas. It could also point to a mistrust of mass media sources and preference for reliance on the opinions and experiences of colleagues. Thus, face-to-face communication, conferences and workshops must be considered an important part of the process of communicating information to others. The slow rate of CMR adoption in the Australian sample could further be interpreted as a possible mismatch between perceived complexity of the innovation by GPs and the communication channel selected to convey information. CMRs may be perceived by GPs as a highly complex technology. Therefore, interpersonal communication may be more important in communicating information about a technology which may be perceived to be complex rather than communicating the information through mass media channels.

Results would suggest that financial investment or reimbursement for the purchase of computer equipment would benefit some GPs but there would still be those who would not know what to do with the technology even if they had a computer on their desk. A computer on a GP's desk needs to be seen as more than just a symbolic ornament. A decision to adopt could, for example, be reflective of a perceived need to keep up with the latest fashion and as a status symbol, giving the appearance of being modern and keeping up with the times, that is, as a form of passive rather than active adoption. This may reflect a lack of computer literacy and knowledge about what

computers can do (the second-most important barrier indicated in both surveys). GP respondents in Sweden indicated that the lack of a CMR software standard among GPs was their main barrier to adoption while Australian respondents indicated that cost was the major inhibiting factor. The results therefore support the conclusions of another Australian study that "non computer users do not know enough about the benefits of computerization to make an informed decision about computerizing" and that cost was a "high priority" [80]. Rogers concurs with these comments, indicating that an individual may not know enough about an innovation for it to be regarded " … as relevant to the individual's situation, and as potentially useful … the individual's attitudes or beliefs about the innovation have much to say about his or her passage through the innovation-knowledge process" [53]. This further supports the conclusions of Moidu, that "training is a crucial factor for dispelling fears in the transfer of technology particularly when the end-users have a high interest but a low level of awareness" [97]. Hence, information and knowledge about CMRs is needed so that an environment of persuasion is created in which adoption can take place. More difficult to determine is whether an individual need for a CMR precedes the technology or whether knowledge of CMRs creates a need for the technology. It is also of interest to note patient reactions to GP computer use. Fitter, for example, indicates that "… studies suggest that the overall impact on patients is small … patients experiences in computer use have more positive attitudes towards doctors using computers" [94]. This would seem to be reflective of a wider conditioning process occurring in society.

Another barrier to adoption that arises from the qualitative responses is finding the time to transfer over from a paper-based patient records system to a CMR system,

especially the laborious task of having to enter patient information into the system. This can be somewhat difficult to overcome since trying to scan hand-written notes on a card file, which may only be legible to the GP, is not really an option. It implies a longer-term phasing-in process, possibly associated with patients' visits to the GP. As each patient comes to see the GP, his or her paper records can gradually be transferred to the computer.

Careful consideration needs to be given to the argument that cost is a major barrier to adoption. Certainly, cost is an issue and past research has indicated that adopters underestimate the actual cost of adoption [58, 70], but is it the barrier that we are led to believe? It may well be that the perceived benefits do not outweigh the perceived costs involved, for it would follow that GPs would pay if the advantages were equal to or greater than the cost. A secondary line of thought, therefore, may be that cost is used as a strategy to divert attention from the real issue, and that the perceived cost of having to learn something new outweighs any potential monetary benefit from using CMRs. Time spent on learning to use computers and CMRs cannot necessarily be quantified but still counts as a perceived cost of adoption. This highlights some of the problems with conducting cost-benefit analyses since not all benefits or costs can be quantified; there may be qualitative benefits which in subtle ways may influence the overall process of work but are not directly connected with improvement, for example, improved appearance and quality of patient records, improved editing capability, time savings and improved data security. Benefits and costs are therefore essentially a matter of perception. The danger in just using a cost-benefits analysis to justify the use or non-use of CMRs on a quantifiable basis is open to serious limitations and critique.

Results from the survey data indicate what can be called an attitude paradox. In the Swedish survey, among the non-users, a positive attitude is associated with an intention to adopt in the near future. In the Australian survey, even when non-users indicate a positive attitude they have no intention of adopting. Therefore, a positive attitude is not sufficient for adoption but may only be desirable. This finding supports the general belief that new knowledge and attitudes by themselves are not sufficient to bring about a change in behavior. Other socio-political reasons need to be considered rather than just behavioral or technical reasons. The survey work shows a need to clarify legal, social and political debates over CMR ownership, CMR legal status, stakeholder access rights, responsibilities, GP loss of power issues and funding models.

Limitations and suggestions for future research design

Mention needs to be made of the limitations of this study and the limitation of using a survey as a research methodology. Limitations help to understand and locate some of the survey findings in a more meaningful context as well as to help other researchers with the design of future diffusion surveys. The works of Kaplan and Duchon, Leedy, and Neuman are informative in this respect [98-100].

One key point needs to be made before undertaking a mail-out survey: the investigator(s) need to know that a mailing list sample can be compiled from a comprehensive list of the target population. This is not to say that a sample cannot be composed without a list of the relevant population but it may have implications for

both the design methodology and the feasibility of the project. There may be a cost involved or the actual mailing list may not be available to the public (i.e. it may be seen as a closely held organizational asset).

Respondents may have a vested interest in responding to the survey and hence distort the picture of events. If possible, it would be worthwhile to investigate the non-respondents and the reasons for their non-response. Some GPs may well be reluctant to disclose they are non-computerized because they perceive the survey to have a positive bias towards computers and CMR usage. Those who are computerized, therefore, may well be more inclined to respond in order to promote CMR adoption. Furthermore, since the focus of this survey was on CMR usage rather than just computer usage, only those using CMRs are likely to have been positively inclined to respond. A different target audience could yield a different perspective, for example, instead of GPs who may or may not have a vested interest in CMRs, a survey of practice patients or the general public could be useful in order to ascertain another picture as to the state of computer and CMR usage among GPs since they could be seen as a more objective third party.

Home computer adoption was not examined, future research may wish to include questions about home computer usage as this could have some bearing on computer use in the workplace. Also, a question about GP income levels may need to be included to see if there is an association with computer and CMR adoption. However, asking about levels of income can be a sensitive issue. The work of Bolton and Gay (1995) indicates a possible association between income level, practice size and CMR adoption. Larger practices with high incomes tended to adopt CMRs more readily.

Errors can also creep into the survey due to a lack of understanding of the terminology, through definitional problems, and differences over what the respondents perceive they use the computer for, especially in cross cultural studies requiring translations. Respondents may, for example, equate computer usage with CMR usage, hence resulting in an over representation of CMR usage. This also suggests another limitation in that self administered questionnaires about computer usage can also be somewhat problematic in that users may base their answers on what they think they may do or would like to do rather than on what they actually do in practice. Hence, the need to provide specific definitions of terms as part of the cover letter and also the possible need for further follow-up through observation and interviews. This may only be possible in longitudinal studies and where respondents are willing to identify themselves.

Conclusions and Recommendations

As the Australian survey findings showed, a high awareness and favorable attitudes towards CHRs are not necessarily associated with the action to adopt as can be seen in the case of the Australian non-computerized respondents. This may in part be due to the fact that such individuals do not consider their existing paper record management practices as a problem. The Australian results may further be associated with perceptions of possible undesirable consequences following from the adoption and implementation of computers in the minds of GPs. On the other hand, the Swedish results demonstrate a different situation altogether as can be seen from the Swedish

non-computerized respondents where a high level of awareness and favorable attitudes are associated with a direct intention to adopt.

The paradoxical finding between the Australian and Swedish study demonstrably shows that a positive belief about CHRs does not necessarily correspond to actual adoption. This can further be described as a discrepancy problem between attitude and practice, that is, between rhetoric and action. Direct interventionist strategies such as standards setting, reimbursement schemes, training programs and the offering of grants can only provide a partial means for controlling the work practice behavior of GPs. Other strategies involve greater information flow through professional networks, journals, conferences, training sessions etc. This effort involves the mobilization of many organizational networks and disciplines: the (re)creation and merging of journals, courses, degrees and organizations so as to reflect this reorientation or change in thinking about the role of CHRs in an e-health environment.

The results from the Swedish study support the argument that the process of diffusion can be controlled at least to a certain extent. In Sweden, a direct financial incentive has been provided by the governing bodies at the County Council level for GPs to adopt CHRs. This can be interpreted as a direct policy initiative to computerize GPs, whether they like it or not, similar to the "Micros for GPs" scheme in the UK, also a type of forced regulatory obligation [70]. In return the Councils expect standardized monthly aggregated reports from the GPs in order for them to be paid. The Swedish result is even more interesting in that, despite being forced to computerize, GPs still have a positive attitude towards using CHRs. This reflects a deeper belief that the utilization of CHRs is an improvement upon past work practices.

Since conducting this study the Australian Federal Government's Practice Incentives Program, introduced in 2000/2001 is helping to increase the utilization of computers for clinical purposes. Government payments are made to GPs who use computers essentially for prescription writing and electronically sending and receiving clinical information. The Government also introduced Health Privacy Legislation as part of its amendments to the Privacy Act (1988) which now covers the collection, storage, use and disclosure of patient information by which GPs have to abide by. This came into force in December 2001 [101]. At a national level, the most recent study of GP computer utilization was the Western et al. study, which found that 89% of Australian GPs use computers and that computers are more likely to be used for administrative purposes than clinical purposes [102]. This is a substantial increase on the results reported in an earlier national study by AC Neilson which indicated the computerization level to be at 31% and that a combination of administrative and clinical use of computers was common, however, less so for clinical purposes [103]. Clinical notes were seen to be the least common.

Suggestions for increased utilization and future research

There is a long-standing need to decide upon a national standard for an integrated CHR and practice management software for GPs in Australia and to encourage other health providers to adopt the same standard. The national standard should fit into the general development of a future health communications infrastructure, the Health Connect project between GPs, hospitals, pathology, insurers, government and other health care providers [104]. The Australian Coordinated Care Trials were in part an

attempt to experiment with CHR use in a more comprehensive and integrated way [105].

The following are some specific suggestions that resulted from the data collected and despite being context specific to the Australian scene can be more generally extrapolated to other health care systems:

- need for an integrated CHR system, must meet GP (and other stakeholder) needs and cater for patient confidentiality/privacy, must have an easy to use graphical user interface, screen displays should be easy to read and not cluttered with too much information.

- CHR use should not interfere with the physician-patient encounter, the CHR system should have appropriate security features built into the design (e.g. encryption, passwords, audit logs).

- The system must include a comprehensive query and statistical generation component so that GPs are able to interrogate the practice population database. Graphical and visual tools to display data would also be desirable.

- If a CHR standard cannot be agreed upon, a standard should be encouraged, *de facto*, or, at least, a minimum data standard should be established for the transmission of health data (e.g. HL7) and security (e.g. public or private key encryption).

- National Health Policy should specifically address and indicate the importance of CHRs in its vision for a reformed health care system. There is a need to develop uniform national legislation for patient information and CHR use, the amendments to the Privacy Act (1988) which came into force in December 2001 are a step in the right direction.

- A national CHR Institute should be set up for greater coordination of resources and research into CHRs. Representatives from the wider community and all interested stakeholder should be involved.

- A comprehensive national health data dictionary would inevitably be a valuable public resource but this has social implications beyond the mere collection and retrieval of information. Issues of centralization, control, ownership and confidentiality are inevitably associated with such developments. Efforts to develop a standard GP Data Dictionary can also be considered important and this should be a subset of the greater national health data dictionary. Careful thought will be required to determine what data elements are needed both now and in the future, in order to accommodate all stakeholders involved.

- GP Divisions in Australia need to be treated as social diffusion networks. Pilot GP Practice success centers within GP Divisions can be established and showcased as centers of excellence.

- Target technology champions and opinion leaders as the key information diffusers within GP Divisions; these may be the pilot success center GPs. Each success center can act as a regional support site for interested GPs to visit.

- Enlist technology diffusion mediators and facilitators. These individuals should ideally have a broader awareness of health informatics, technology diffusion and an understanding of GP settings and e-health developments nationally and internationally.

- Set up a national GP IT "help center" which GPs can call toll free when needing help and advice with CHR implementation.

- A wider mass media strategy is desirable (TV, radio, newspapers, WWW) so as to create greater awareness of CHRs, telemedicine, health informatics and e-health within the community.

- Sufficient conference forums presently exist at the national level (e.g. The Australian Health Informatics Conference, The RACGP Computer Conference) for general health informatics information diffusion. What is needed is greater consolidation of the various initiatives, research findings, clinical trials and so on in order to provide a greater sense of direction. Otherwise, islands of uncoordinated, disparate research will proliferate among private research organizations and universities.

- There is a need for the development of a bibliographic directory of past efforts, as well as existing on-going research into CHRs and telemedicine, both within Australia and internationally. This could be a home page sitting on the WWW which would be easier to update than a paper based publication and could contain hyperlinks to the associated project, the researchers and reports.

- Computer and CHR education, information dissemination, debate, training and support are vital within the GP Divisions in Australia. There is a need to develop and integrate computing and statistical competencies into future medical training qualifications and programs. This would allow for more and better epidemiological studies by GPs operating at the practice level.

- Greater involvement of professional bodies in Australia such as ACHI, HISA, RACGP, AMA and interaction with the Federal and State Health Departments.

- Need for more financial incentive schemes for GPs to computerize, for example, Medclaims ($500 rebate from the Australian Health Insurance Commission). This sum could be increased.

- Financial incentives from Government, RACGP, AMA, HISA, industry and other possible stakeholders. Financial support (public and private) to encourage CHR development and diffusion is important and cost sharing among stakeholders should be encouraged. As a start, financing issues should be addressed by GP Divisions within their IT strategic plans, i.e. how to obtain sources of funding through, for example, collaborative grant applications. Voluntary adoption may be

preferable to mandated adoption. The key is to create an environment in which GPs will voluntarily adopt without direct coercion. The alternative is for the Federal Government to regulate CHRs as a national standard for GPs, which would undoubtedly create some dissent.

- Greater visibility of pilot projects documenting CHR adoption before, during and after implementation. These can be written up as case studies. This allows for verification of the rhetoric about CHR technology against social reality and current practice, for example, e.g. costs, benefits, design problems, unintended consequences, loss of power issues and general practice impact studies.

- Greater collaboration between GPs, researchers, professional bodies, local area health services and government needs to be encouraged especially in grant applications.

- Research into the use and development of consumer health web portals, smart tokens/cards, biometric identification and PDA applications by patients and healthcare workers all need to be carefully evaluated as do accompanying workflow process models.

The central argument of this chapter has been that CHR systems need to be seen as a fundamental building block for primary health care globally. In order for grander visions of telemedicine and e-health to take place, CHR utilization among GPs is seen as a key linking element. Successful adoption strategies drawn from countries with a high rate of adoption, such as Sweden, can serve as useful learning models for

devising national plans. The caveat is that it is still necessary to carefully examine the attitudes of local GPs (the main users) towards CHRs with an eye on international developments in e-health. The development and further diffusion of CHRs, telemedicine and e-health are not only a reflection upon the motivations, attitudes and alliances between the actors involved within social and professional networks but also upon government policy, legislation and funding mechanisms.

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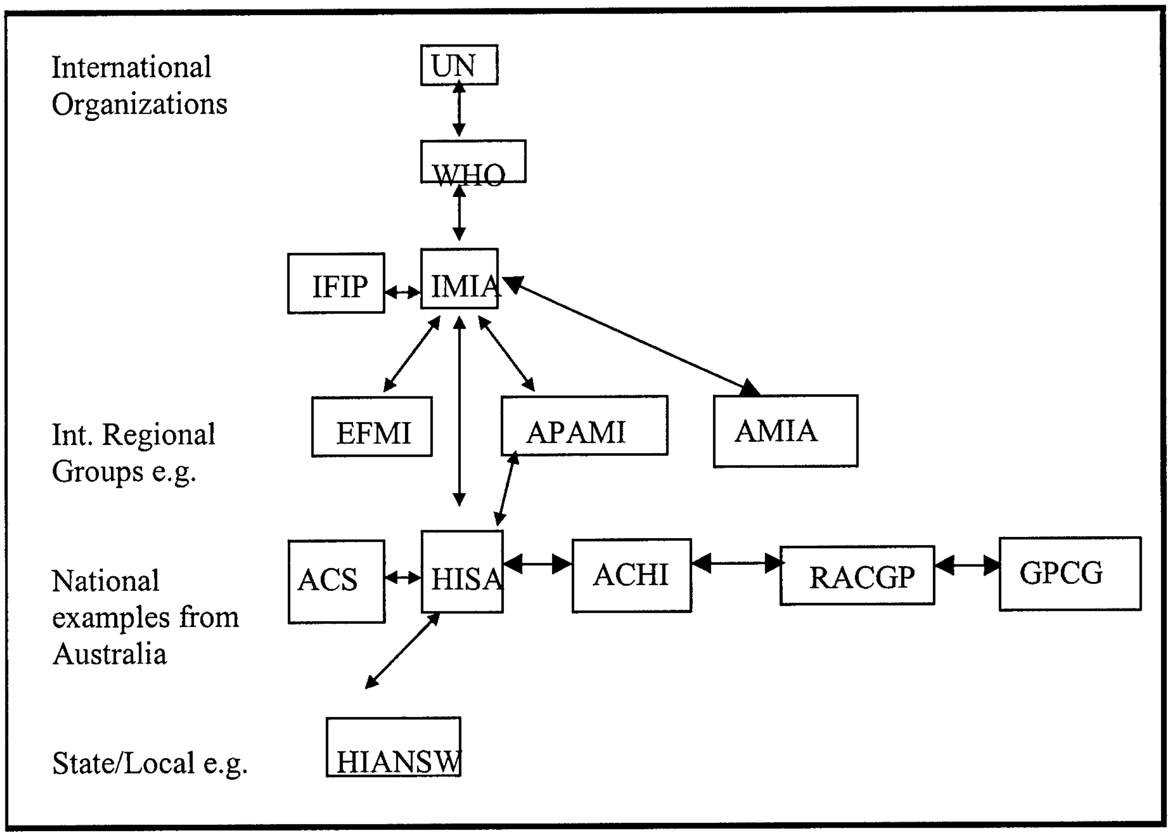
Figure 1. Overview of some organizational actors and alliances constructed to promote health/medical informatics utilization



Developing Strategic Alliances for Telemedicine

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INTRODUCTION

This chapter focuses on the role of alliances among various actors – individuals, organizations, communities and networks – in an effort to understand the range of human factors that influence telemedicine utilization and sustainability (1). Actors form alliances to accomplish that which they cannot accomplish alone (1-9). Healthcare organizations often develop alliances with other organizations to enable the delivery of telemedicine services (5, 9-10). These interorganizational arrangements are often initiated as a result of grant funding received by one of the participating organizations (12). All too often these telemedicine alliances are underutilized and end after the grant period (13).

Luke, Begun and Porter (14) propose that *loosely coupled* interorganizational arrangements created to achieve short-term objectives tend to dissolve because they never seen by the participating organizations as strategically important. They argue that *loosely coupled* interorganizational relationships developed for long-term strategic purposes are more likely to last. A Five Step Process developed to 1) identify organizations appropriate for exploring a telemedicine alliance and 2) guide the development of alliances that assure ongoing telemedicine utilization and assure long-term sustainability is presented. The steps of the process are:

1. Build upon existing relationships
2. Develop co-champions
3. Engage the team
4. Secure executive commitment
5. Gain community support[DCB1]

A case study approach is used to describe the real world application of these steps in building strategic alliances among an academic health science center and health professions

programs at three universities. This process was developed over the years from 1992 through 2000 and grew out of the combined experiences of the authors. The first telemedicine alliance is being sustained, but is not growing. The second continues to grow and thrive. Attempts to develop the third alliance were suspended in the second step of the process.

The Five Step Process is not undertaken in isolation of the other *layers* of human factor influences discussed in the editorial commentary (1). Nor does completion of these steps guarantee a well-utilized and sustainable telemedicine program. However, the process ensures that the telemedicine alliances are strategic in nature, based upon shared values and objectives, and aligned with the respective missions and strategic directions of the individuals, organizations, communities and societal sectors involved.

BACKGROUND

The case study covers the timeframe from 1990-2001 and reflects the experience of an academic health science center working with health professions programs in three state universities to establish a telemedicine program. Feature characteristics of these institutions and the development of their interorganizational relationships over time are described below.

The academic health science center (HSC) is situated in the southwestern region of the United States on a barrier island 50 miles south of a major metropolitan area of five million people. The island population is 60,000 and the overall county population is 250,000. Just over 2,000 students and 550 medical residents are enrolled in the academic health science center's schools of medicine, nursing, allied health, and graduate biomedical sciences. The HSC employs over 1000 faculty and 10,000 staff. The university's state-supported health care network includes eight on-campus hospitals and a network of campus- and community-based clinics that offer primary and specialty care throughout a 228 county area.

The three state universities are located 100 to 350 miles from the HSC (see Table 1). University A is nearest to the HSC and is situated in a city of 110,000 amidst a metropolitan statistical area of 250,000. The other two universities are located in cities of approximately 30,000. University B is in a rural area. University C is in a metropolitan area of over 500,000. The enrollments, faculty sizes and ratios of students to faculty of the three universities are similar. However, University B – located in a rural area – offers more undergraduate and graduate degrees with fewer faculty members than its urban counterparts.

Table 1. Feature characteristics of alliance universities

Characteristic	University A	University B	University C
Miles from HSC	100	185	350
City Population	110,000	30,000	30,000
County Population	250,000	60,000	500,000
# Of Students Enrolled	9,800	10,000	14,400
# Of Faculty	490	525	660
Ratio of students to faculty	20	19	22
# Of Undergraduate Degrees	76	94	51
# Of Graduate Degrees	33	60	45
Partner program	Nursing department	Nursing division	Physician Assistant program

In 1990 the HSC began offering a joint graduate nursing degree at University A (see Table 2). HSC faculty used a combination of on-site videotaped classes. The two-hour commute (100 miles), while demanding was doable. University B also wanted to offer the joint nursing degree. However, the 185-mile (3 ½ hour) commute was unrealistic.

In 1991, the HSC received federal funding to initiate an Area Health Education Center (AHEC) charged with developing community-academic partnerships to improve the supply and distribution of health professionals in rural and underserved areas. University A and University B are each within one of the service regions of the AHEC program. Community-based AHEC offices were opened in 1991 and 1992 in both service regions. University representatives serve on the community boards of each AHEC office. University C is not in the AHEC service region.

All four institutions conduct videoconferencing demonstrations in 1992 (15). As a result of the demonstrations, HSC and University B offer a joint graduate nursing degree via videoconferencing beginning in January 1993.

Table 2. Alliance development timeline

1990	Joint graduate nursing program between HSC and University A begins (faculty commuting supplemented with videotapes)
1991	AHEC created by HSC serving University A's region
1992	• HSC opens AHEC serving University B's region. • All four institutions universities conduct videoconference demonstrations
1993	Joint graduate nursing program between HSC and University B initiated (videoconferencing)
1994	Discussions initiated between HSC and University A to develop a telemedicine alliance
1996	HSC and University A form telemedicine alliance: • Pediatric telemedicine services offered. • Joint graduate nursing degree program transitions to videoconferencing. Joint physician assistant degree program initiated between HSC and University C (videoconferencing)
1997	HSC and University B form telemedicine alliance: • Pediatric telemedicine services offered. • Joint nursing degree program continues.
1998	HSC and University C's attempt to form telemedicine alliance fails.
1999	Independent school districts associated with HSC and University A & B join telemedicine alliance.
2000	Mental health, maternal child health, asthma

HSC and University A began exploring the potential of forming a telemedicine alliance in mid-1994. The steps undertaken to develop this alliance and alliances with University B and University C are the focus of the case study presented later in this chapter.

A telemedicine clinic was opened between HSC and University A in 1996 (16, 17). A second clinic was opened with University B in 1997. Both of these clinics were implemented with without external funding. Once the clinics were operational, the alliance secured external funding was to enhance operational capabilities and expand the project to included University C and six school districts.

The telemedicine alliance with University A is being sustained, but is not growing. The alliance with University B continues to grow and thrive. The alliance with University C was never implemented.

The Five Step Process used to identify and develop these three alliances is described in the case presentation and factors that contributed to the outcomes stated above are discussed. Implications for future practice and research are explored in the discussion.

METHODS

A case study format is applied to describe the Five Step Process (FSP) used to identify and develop strategic telemedicine alliances. The FSP was built upon a premise proposed by Luke, Begun and Porter (14) that *loosely coupled* interorganizational arrangements created to achieve short-term objectives tend to dissolve. In contrast, *loosely coupled* interorganizational relationships developed for long-term strategic purposes are more likely to last because are seen by the participating organizations as strategically important.

The process described in the case presentation that follows is intended to ferret out strategic interorganizational relationships and build upon those relationships to develop telemedicine alliances. The FSP is based upon eight years of experience in developing telemedicine alliances coupled with on the job training and self-study in leadership, change management and community development. Many of the techniques in the FSP use concepts in social exchange theory (max weber, blau, Homans, Tiwana and Bush) (2-10). Following the example of Gagnon and Lamothe, et al. (18), concepts, theoretical frameworks and practices have been adapted to the specific nature of telemedicine, the health care industry, and the socio-political environment in which the work described took place.

Participants of the process conducted this study ex post facto. The authors recognize the potential for bias and misinterpretation inherent in self-studies and ex post facto analyses. However, human factor influences on telemedicine utilization and sustainability are largely unexamined. Self-study and ex post facto analysis have been shown to be useful in

understanding complex, interactive, or systemic social phenomena, especially relatively innovative and unstudied topics (19). Case studies are used to identify variables for future study and explore the nature, strength and direction of relationships among variables (19-21).

Data used in the case study include internal documents – such as grant applications, reports, meeting minutes, internal memorandums, and emails – as well as informal interviews and discussions among participants. A review of the literature places the process under study within a theoretical framework and provides a context for discussing the implications of this study for future practice and research (19).

CASE PRESENTATION

A Five Step Process used to identify and develop strategic alliances for telemedicine between an academic health science center and health professions programs at three universities is described below. Rationales for undertaking steps and techniques used to accomplish each are explained. The case is then presented and factors that contributed to the case outcomes are proposed.

This process is presented to assist program managers in identifying the key players, designing projects, securing resources, and operating and sustaining telemedicine services. The steps are as follows: 1) build upon existing relationships, 2) develop co-champions, 3) engage the team, 4) secure executive commitment, and 5) gain community support[DCB2].

Step 1. Build upon existing relationships

This step in the process is based upon the assumption that strongest and most lasting telemedicine alliances are often built upon existing relationships. The rationale being that there is already a basis for the relationship to exist. Likely, there is a set of shared understandings and

a level of trust already established. The relationship may be personal, professional, organizational or community-oriented.

Scan the organization to get a sense of the outreach or community-based activities in which the organization is already involved. These activities may be clinical, educational, research or community service oriented. Students may be placed in a community practice, clinic or hospital to gain community-based training experience. A good source is an Area Health Education Center (AHEC) or similar community-based organization working support health care professions education. Faculty members may be collaborating on research projects with faculty at another institution. Nursing or allied health programs may be offering distance education degrees at a local college or university. A provider or administrator within the organization may sit on the board of a local company or vice versa.

Questions to be asked are: Can the existing relationship be enhanced or expanded with the addition of telemedicine? Can that person or organization facilitate introductions to other institutional or community members who may be interested in telemedicine?

Case Study Scenario 1. Build upon existing relationships
University A – prior relationship with HSC well established; attempt to form telemedicine alliance proceeds.
In 1994 HSC and the nursing program University A began discussing the feasibility of forming a telemedicine alliance. Eighteen months passed between initial discussions and opening of the clinic in the fall of 1996 (17). The timing and relationship seemed to be ripe for forming a telemedicine alliance for several reasons. *First*, HSC and University A had been working together successfully for four years to offer the joint nursing degree program (see Table 2). *Second*, HSC had established a community-based education outreach program – an Area Health Education Center (AHEC) –

that opened a regional center in 1991 serving an area encompassing the HSC and University A. Nursing representatives from University A were on the regional center's advisory board and the organizations had collaborated on various education initiatives to the region – including the joint nursing degree program. *Third*, University A had conducted a videoconferencing demonstration in 1993 in cooperation with a public school system. *Fourth,* the nursing program at University A had conducted a needs assessment of public schools in their service area that had revealed the increasing challenge nurses and teachers were facing in coping with the health care demands of rising numbers of children with special needs being mainstreamed into the classroom. *Fifth*, the region surrounding University A was a primary source of referrals for the HSC, and specifically, for the pediatric subspecialty interested in providing telemedicine services. *Sixth,* equipment prices had dropped significantly and the state had passed a telecommunications act mandating reduced telecommunication rates for educational institutions and non-profit health care.

University B – prior relationship with HSC is guarded; attempt to form telemedicine alliance proceeds after intervention of trusted colleague at University A.

HSC and University B initiated a joint nursing degree via videoconferencing immediately following the demonstrations in 1993 (see table 2). From the time equipment was installed in January 1994 through the fall 1997, the videoconference system at University B was used solely for the joint nursing degree program. Utilization averaged 25 hours per month or 5 hours per week for nine months out of the year.

The videoconference system at University B was purchased and managed by the HSC technical group. The dedicated telecommunications line was also paid for by HSC. University B offered to share the cost of the equipment and connectivity, but the HSC declined the offer.

The HSC operated and controlled access to the equipment. University B's technical group was refused unsupervised access, prior approval was required before University B could use the system, and a fee was invoked if University B wanted to use the system for anything other than the joint nursing degree program. These rules were also applied to the regional AHEC office that operated under a subcontract from HSC to University B. University B housed the equipment and provided classroom space without cost to HSC.

Despite successes with the videoconference demonstration, the joint nursing degree, and development of a local AHEC program, policies related to ownership, management, and use of the videoconferencing system inhibited development of additional programs for 2 ½ years. The rift with the head of nursing at University B was mitigated when the head of nursing at University A shared their success in establishing a telemedicine alliance with the HSC (see discussion above). Building upon the relationship between the nursing leadership, a telemedicine clinic opened in partnership nursing program at University B in the fall of 1997.

University C – prior relationship with HSC new; attempt to a form telemedicine alliance suspended

HSC and University C initiated a physician assistant (PA) degree program offered via videoconferencing in 1996. The PA program director at University C was approached about forming a telemedicine alliance in 1997. Although one patient was seen through telemedicine, the alliance was never formalized.

The nursing degree and the PA degree were both conferred by the HSC, but the interorganizational relationships were structured differently. The relationship between the HSC and University C differed from the relationships with the other two universities in *four* ways. *First*, the joint degree program was an undergraduate allied health degree rather than a

graduate nursing degree. *Second,* the program director at University C was an employee of the HSC, not University C. In contrast, coordinators for the nursing program at University A and B were employees of their respective universities and students in the joint degree program. *Third*, the PA program was seen as a peripheral program at University C, i.e., members of the health science department did not consider it a part of the university. The nursing degree program was viewed as part of the local nursing units. *Fourth*, University C offered a joint graduate nursing degree with another health science center. University C's nursing program expressed disappointment upon learning of HSC efforts to form a telemedicine alliance through the PA program rather than the nursing program – as had been done at the other two universities.

Step 2. Develop co-champions

Identify a power broker and operations leader

Identify two champions in each organization in the proposed alliance. Within the initiating organization, the co-champions should have between them administrative/business expertise, clinical expertise, and relationship management skills. In a health provider organization, the champion with clinical expertise is often a physician. This may not be true in non-health organizations such as public schools. The operations leader may come from any part of the organization, but often has community outreach or community development responsibilities.

If the co-champions come from different parts of the organization, they should be able to access the power structure within their respective domains of influence. That is, they should be able to engage the appropriate people from the executive levels of the organization. Also one or

both champions should understand or have access persons with a basic understanding of accepted business practices, clinical operations and technical requirements/capabilities.

Within the target organization, two champions should be identified to assist in alliance development. One champion – referred to as the power broker – should have access to the power structure within the organization and community – again, someone who can get the executive level to the table. The other champion should be more oriented toward frontline operations with strong skills and interest in working with patients, students and colleagues – referred to here as operations leader. The two champions must communicate and work well together.

Uncover the value

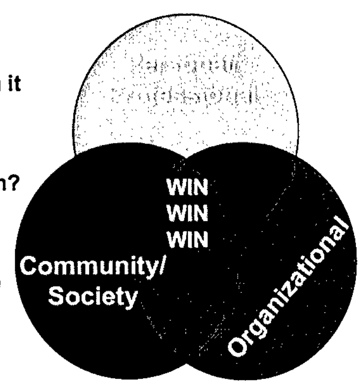
Numerous meetings, phone calls, and/or e-mails with the power broker may be required to discover the power broker's personal/professional interests in telemedicine, their organization's interests, and the interests of the larger community. They must also understand the potential challenges and opportunities at each of these levels (see Figure 1).

This is an exploratory process. Often people only have an abstract idea of why they, their organization or community are interested in engaging in telemedicine. Uncovering "What's in it for me?" (WIFM) at the personal/professional, organizational, and community level will help to structure the alliance and design a project that is aligned with the strategic objectives of at all levels.

Figure 1. Uncover the value

What is in it for me?

- WIFM-What's in it for me?
- What is in it for my organization?
- What is in it for society, the community, the patient, the broader good?



The process of uncovering the value assumes a level of trust, collaborative spirit and creativity among the key players. Each key player should be willing to help others achieve their

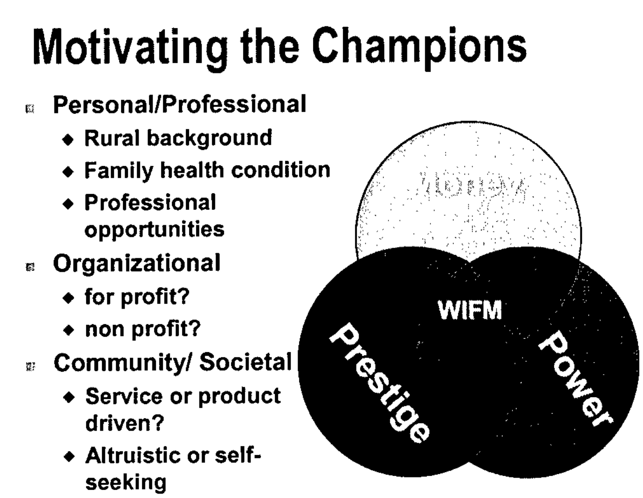
respective goals. Finding common interests that overlap in personal/professional, organizational, and community/societal realms is desirable. The solutions lie where there is a convergence of interests and objectives among the parties and levels.

To uncover the WIFM from others, the co-champions from the initiating organization should reveal theirs first. What attracted them to health care, education or public service? How is their role in the organization aligned with their personal values and/or professional aspirations? How might this project support their personal/professional goals while contributing to the organization's mission? Is there an altruistic or public good that will come from the project that is bigger than the individual or organization or community in question? If someone is in academia, are they most interested in teaching, conducting research or providing patient care? How does the organization reward people and for what?

Understand the motivation

The individuals and organizations must be clear about alliance goals (see Figure 2). Is the alliance being formed to make money? Will the alliance confer prestige or increase individual or organizational power? What is the relative importance of these dimensions of social and economic status to the individual (personally or professionally), to the organization, to the community, region, or industry of which the individual and organization is a part?

Figure 2. Understand the Motivation



As one individual shares their motivation, others will feel comfortable in expressing their own. Everyone has desires and

needs. Asking them to explore how this proposed alliance may help them achieve their goals, gives legitimacy to their needs while opening the door to engage them in helping find common goals to assure success of the project.

People and organizations are approached differently depending upon whether they are interested more by money, power or prestige. Every position, organization and community has varying levels of these dimensions. Each dimension is essential to the success of a project and an alliance.

It is not always necessary to ask what motivates an individual or organization. Sometimes walking into a person's office offers clues as to what they care about. Do they have pictures on the wall with powerful people? Sometimes watching how someone relates in meetings will reveal what they value. Look for cues in conversation. Do they talk a lot about money? About powerful or famous people they know? Again, look for patterns, not isolated instances.

By knowing someone's position title, the relative importance of each of these dimensions can often be inferred. For instance, a chief executive officer (CEO) or chief financial officer (CFO) is probably most concerned about the financial and business impacts of telemedicine – i.e., money or market influence. From the CFO's perspective, prestige and power are likely to be considered only within the context of how these dimensions contribute to the financial picture. A CFO may see telemedicine as simultaneously exposing the organization to the threat of increased competition or expanding market opportunities.

A CEO may be interested in how telemedicine increases the likelihood of recruiting and retaining qualified health care professionals. So providing opportunities for collegial exchange, professional consultation, professional education, and direct referral access may be important.

Physicians have high prestige, make good money, and wield life-determining power. Yet physicians in academia may be more likely to value prestige or power more than money. Physicians in private practice may be more motivated money or power than prestige. Getting to know physicians helps in understanding what they value most.

Do not overlook the technicians, nurses, allied health, and administrative staff when exploring motivations. Technicians, for instance, are frequently concerned with control. They are responsible for controlling access to confidential information and guaranteeing reliable service. If they perceive developing new alliance will create vulnerabilities in their network, they will resist. Many difficulties can be avoided by understanding the interest underlying their resistance.

These dimensions motivate organizations, communities, regions, states, and countries as well. It is important to understand how these dimensions drive action in for-profits versus non-profits, economically depressed versus economically prosperous communities, rural versus urban, inner city versus suburbs, academic health centers versus community health centers, young organizations versus established organizations, etc.

Seek to understand; not judge

None of the socioeconomic dimensions (power, money or prestige) are good or bad, or better or worse than each other. The project needs to be visible, well positioned, and solvent. Understanding the relative importance of each dimension for each of the actors – whether the actor is an individual, organization or community -- allows for the development of a more strategic alliance – an alliance aligned with the values and objectives various actors. This will ensure that individuals and organizations are invested in the success of the alliance because the success of the alliance is linked to their success.

Knowing what drives people and organizations also makes it easier to match them to the appropriate role and responsibility within the alliance. Engage those who value prestige in marketing efforts such as newspaper or television coverage. Engage power brokers in getting upper management support for resources. Engage CFOs' in finding the return on investment. Once the "what's in it for me" (WIFM) in each of these realms (personal/professional, organizational, community/societal) is understood, the champions from initiating and target organizations work together to develop plans formalizing the alliance and implementing the project to meet these interests.

Case Study Scenario 2. Develop Co-Champions

Health Science Center Co-Champions – Clinical leader and relationship manager team up to form community alliances.

At the HSC, a pediatrician who envisioned using telemedicine to take care of special needs children became the power broker. The operations leader functioned as relationship manager and business leader. The operations leader worked for an HSC outreach organization, Area Health Education Center (AHEC), and had coordinated the three-month demonstration project. The pediatrician participated in the demonstration and concluded that the technology could be used to better serve patients and their families. By the end of the demonstration period, the operations leader had concluded that the technology would be a key strategy for achieving the AHEC mission, which complemented both the educational and clinical goals of the AHEC.

The videoconferencing system purchased by the HSC to support the nursing joint degree program was centrally located on campus and could be used for the pediatric telemedicine clinic. Five hours of clinic per month would be required to meet the need given the size of the patient population to be served. However, five hours of utilization was too little to justify the investment in equipment and connectivity in the community. Even if the technology investment

could be justified, there were no facilities or staff to operate the clinic on the patient end.

Compounding the challenge, the patient population was geographically distributed and was cared for by a variety of independent community providers. A neutral community site was needed to assure that patient of all community providers had equal access.

The relationship operations leader proposed the establishment of the telemedicine clinic in conjunction with the joint nursing degree program. Equipment and a technological link were in place. And the nursing program would not be seen as a competitor to local providers. However, due to the breach between University B and HSC, approaching University B to provide space and staff to operate the clinic was not realistic.

The relationship with University A was good, but they did not have the necessary technology. However, University A was interested in transitioning the ongoing joint degree program from faculty commuting to videoconferencing.

University A Co-Champions – Power broker and operations manager identified; alliance formation proceeds.

At University A, the head of nursing served as the power broker. A nursing faculty member who was also a student in the joint degree program was the operations leader.

The head of nursing had been instrumental in bringing the joint degree program to the university and had a vision for enhancing that program by incorporating videoconferencing. The power broker also wanted to start a faculty clinical practice to enhance faculty prestige, maintain faculty practice proficiencies, provide clinical experience for students, and generate revenue and visibility for the institution. The power broker was enthusiastic about providing telemedicine services after recognizing that the telemedicine clinic would provide opportunities for faculty practice and student learning while providing a valuable community service, demonstrating the

university's progressiveness and strengthening a valued organizational alliance.

The faculty member who served as the operations leader was enrolled in the joint graduate nursing degree program offered by HSC at University A. With videoconferencing, the learning experience through the distance education program would be enhanced. By running the telemedicine clinic, the operations leader would gain clinical experience and be able to expose nursing students to leading edge health service delivery technologies. In addition, the faculty member would be an innovative leader among academic peers and within the larger health care community.

University B Co-Champions – Power broker and operations manager identified; alliance formation proceeds.

At University B, the head of nursing also served as the power broker. As with University A, a faculty member enrolled in the HSC joint degree program at University B, served as the operations leader.

Due to the influence of the head of nursing at University A, University B was now interested in initiating a telemedicine clinic. As mentioned earlier, the power broker at University A had brokered initial telemedicine related discussions between the power broker at University B and the operations leader at Health Science Center. *Secondly*, the regional office of the Area Health Education Center had been working with the head of nursing on health professions education issues. *Thirdly*, the region surrounding University B was a secondary referral area for the HSC, and specifically, for the pediatric subspecialty interested in providing telemedicine services. *Fourth*, enough time had passed for the technical group at the HSC to recognize that they needed to remove barriers to access and encourage utilization if they expected the institution and by that time – the AHEC – to continue funding the costs of the

connectivity.

The rationale for initiating the telemedicine clinic at University B would differ from University A. The head of nursing at University B saw the telemedicine clinic as an opportunity to strengthen the student service-learning program within the nursing division and to involve all of the health-related programs in the telemedicine alliance.

University C Co-Champions – Operations manager identified, but no power broker; attempts to form alliance discontinued.

At University C, the program director for the joint PA degree program was unable to secure a meeting with upper level administration. As discussions progressed, it became clear that the PA program was peripheral to the health science department, and by association, so was the program director. The peripheral nature of the PA program appeared to be due, in part, to how the physician assistant program was structured within University C. The HSC took total responsibility for the success of the program including employing separate program staff.

In addition, the nursing program expressed resentment in not being chosen over the PA as the point of contact for forming the alliance and operating the clinic. The long-standing competition between nurse practitioner and physician assistant programs may have accounted for some of the difficulties.

The program director could have functioned effectively as the operations expert. But without a power broker to engage and solidify institutional support, cope with departmental politics between the NP and PA programs, and represent community interests and concerns, efforts to develop the alliance were discontinued.

Once the co-champions from each organization are identified, the goals and objectives are clear, and rough estimates of costs are determined, the power brokers from each organization

should informally vet the project with each organization's leadership. At this stage the alliance is moving from concept to design. It is important to inform key leadership about the project prior to reaching throughout the organization to pull a project team together. If the leadership has a concern, it should be addressed up front. Also, as a courtesy, the leadership should never be the "last to know".

Step 3. Engage the team

Both strategic and business planning was undertaken to provide a long-range, comprehensive approach, and optimize all investments in infrastructure, human resources, hardware, software and skills, and to minimize redundancy and waste (17). Through strategic planning, a common vision, goals, and priorities were developed and then communicated among all levels of the telemedicine team, throughout the universities, within the community. Business planning efforts included a thorough needs assessment, early and ongoing user input, and a clear understanding of the existing health care delivery system serving the targeted population. In planning for installation and purchase of the technology components, factors considered included: the rapidly changing nature of the technology, the architecture and design of clinic facilities, and training for staff utilizing the technology.

The next step involves assembling and engaging the project team. The project team works together to flesh out the implementation plan clearly articulating what is to be accomplished, how, where, when, by whom and how to sell the project within and outside of each of the alliance organizations. Anyone within the alliance member organizations whose role or responsibility will be impacted by the development of the alliance and/or provision of the telemedicine service should be considered a part of the project team. The co-champions at each organization are responsible for identifying the appropriate people and discussing the project

with them. If needed, the co-champions will set up a meeting with the other alliance organizations to discuss the project, its impact on their area of concern and the role they will assume or the action needed. People that may need to be involved include technical support as well as anyone concerned with medical records, security and privacy, risk management, contract management, space allocation, etc. However, given the central importance of technical experts to the success of the project, the rest of this section will focus on engaging them. The same principles can be applied to other people who will play a key role in the project.

Each pair of champions should introduce the project to the technical leaders within their respective organizations and ask them to attend a technical planning meeting. The purpose of the technical meeting is three fold. *First*, the co-champions and the technical people at each organization should understand the existing technical capabilities at the other alliance organizations.

Second, the technical people should understand what the co-champions want to accomplish and with whom so that they can understand the value and the importance of their role. The technical people will be responsible for selecting the technology appropriate to the need, providing cost estimates, purchasing, installing and maintaining the technology once the telemedicine service is implemented. It is not uncommon for the champions of a telemedicine project to bypass the internal technical team. Vendors will cooperate because their interest is in selling their equipment or service. The technical people are then called after the equipment or service is purchased – or worse yet – they find out during or after installation when the vendor has gone away and users are experiencing difficulty.

Third, rapport needs to be built between the technical people from each organization in order to become a functional team. Often the difficulties encountered during or after installation

are impossible to diagnose in isolation. If the technical teams from the alliance organizations do not have a good working relationship, the project suffers eventually affecting patient care.

Again, the technicians from the telemedicine provider organization should work with technicians at the target organization to increase the knowledge level and expertise at the local level. This enhances the level of technical support available and increases the status of the local technical support within their respective organizations. This person will be invaluable as the project progresses and valuable to the alliance organization and community where there is likely to be a shortage of skilled technicians.

Case Study Scenario 3. Engage project team

Health Science Center Project Team

Before arriving at the decision to establish a telemedicine alliance, executive levels at each university and representative from each of the functional areas of the proposed telemedicine team – from administrators to practitioners to technicians – were engaged in planning efforts. The Area Health Education Center led planning efforts. Once the decision was made to move forward, the project was vetted within the institution. The power broker/clinical champion briefed the clinical department, operations/business leader touched base with the Area Health Education Center leadership, and the technical leader contacted business and finance area. Once the project goals had been well defined and the project had been vetted with key leadership, the technical teams from participating organizations were brought together to put together a more detailed technical plan.

At the HSC, a nurse practitioner and member of the pediatric health care team familiar with the health care team and the operation of the standard clinic, became key to the success of ongoing clinical operations. Once the clinic was implemented, the nurse practitioner

spearheaded day-to-day operations of the clinic. The operations leader continued to focus on managing the interorganizational relationships and developing new applications to increase utilization and strengthen the alliance.

The HSC technical team had gained considerable experience in the year and a half since the videoconference demonstration project. The technical leadership now recognized the need to welcome technicians from away sites onto the team rather than establishing boundaries. The technical team at the HSC provided overall technical design and support, but worked with the technical experts at the universities to integrate the new technology into their environment and realm of responsibility.

University A Project Team

At University A, the nursing department had a nursing informatics expert interested in the technology. Perhaps more importantly, the informatics expert was interested in how to use the technology most effectively within the clinical and educational setting. Consequently, University A's technical expert became intimately involved in setting up and supporting the clinic and distance education classroom. Once the clinic was operational, the expert continued to be involved in operating the videoconference equipment and managing the cameras until standardized practices were established.

To foster the relationship between the technical groups at the HSC and University A, one of the co-champions at the HSC arranged for University A's technical staff to spend two weeks with HSC technical staff to learn more about the technology and how to provide technical support for telemedicine and distance education activities.

University B Project Team

At University B, the nursing division did not have dedicated technical assistance. Due to

the early breach between the HSC and University B technical groups, the nursing division at University B was never able to engage the technical group at University B in supporting the project. The "hands off" policy regarding HSC equipment had become entrenched. Consequently, the HSC continued to provide technical support for the equipment at University A. Given the HSC technical support was limited to making sure the equipment was operational, the nurse operating the clinic was left without a technician to operate the camera. This increased the nurse's stress and resulted in a less efficient clinic.

University C Project Team

At University C, the technical group was ready and willing. Videoconferencing equipment was already in place for the joint PA degree program. However, because a power broker was never identified, the project never received the necessary blessing from University A's leadership or the broader community. The business champion at the initiating organization felt the power broker was essential to overcoming barriers within the institution that we discussed earlier and challenge in the broader health care community that will be discussed later.

Once the plan is in place, the target organization's champions convene the remaining meetings. The initiating organization offers support and helps develop strategy, but the local champions spearhead the initiative within their realm of influence. The co-champions from the initiating organization are guests and helpers in the process.

This point is critical and may be difficult to achieve given the relative importance of power, money, and prestige to each of the players from the initiating organization. It is difficult to take the second chair when the initiating organization champions believe they know more about telemedicine or have a greater stake in the care to be provided. However, the target

organization knows more about the community's health care system and local politics. Furthermore, when the initiating organization's champions go back home, someone in the community will need to continue advocating the alliance and its initiatives and troubleshooting when issues arise.

Therefore, the local champions must become the knowledgeable promoters for the alliance within their organization and community. It is the initiating organization's responsibility to position the local champions for this purpose. The local champions must understand enough to approach leadership within their organization and community and be seen as knowledgeable, trustworthy, and reliable.

Step 4. Secure executive commitment

Once the champions at both organizations are comfortable with the implementation plan, they arrange for an executive briefing with the leadership inside their organizations. The purpose of the executive briefing is to 1) educate the leadership so they are able to talk knowledgeably about the project with community members, 2) answer any lingering questions, 3) introduce leadership to key players and leadership from other alliance organizations, and 4) to get their blessing to move forward.

During this meeting the leadership from the alliance organizations formally and publicly agree to participate. Hopefully, by this meeting, all questions will have been answered so that there will be no surprises. This meeting boosts morale and lifts team spirit as support for the project is demonstrated from the top of the organization down through the operational level. The commitment that is being solidified with this executive briefing could be an agreement to seek funding, deploy infrastructure, expand existing services, etc.

Case Study Scenario 4. Secure executive commitment

Health Science Center Executive Commitment

At HSC, the telemedicine initiative grew as a collaborative effort of the clinical department and the Area Health Education Center (AHEC). The clinical department provided the clinical service. The AHEC provided the business acumen and community ties. The technical team was key to project success because they provided the communication vehicle through which services were delivered and the alliance was strengthened. Therefore, commitment was required from all three functional areas. Within the clinical department, the department chair and vice president for clinical affairs approved the project. Within the Area Health Education Center, the director of the program and the dean/vice president for academic affairs signed off. For the technical group, the vice president for business affairs agreed to the project. Finally, the president/CEO and/or his representative were included in any key meeting, correspondence or decision. This was done through individual meetings and communications through each key player's chain of command. The pediatrician/power broker and business leader worked together to keep the president's office informed.

University A Executive Commitment

At University A, representatives from the HSC met with University A's leadership to outline the proposed project, discuss commitments, opportunities and challenges, and gain executive sign off for moving forward. Attendees from the HSC included the pediatrician/power broker, operations leader, technical leader, and a spokesperson from the office of the chief executive. Attendees from University A included the dean of nursing/power broker, operations, leader, informatics expert, chief executive leadership from University A 's other health related departments and technical support department, and key leaders up the dean

of nursing chain of command including the chief executive.

University B Executive Commitment

At University B, the executive briefing was similar to the briefing at University A with a few exceptions. *First*, the power broker and operations leader at University A joined the executive briefing at University B for about 20 minutes via videoconferencing. They spoke to University B's leadership from a common perspective and were able to vouch for HSC intent and integrity. *Second*, given pre-existing equipment and the lack of involvement of the University B's technical group in project planning; only the executive over the technical area was involved in the executive briefing. The technical area executive gave his blessing, but provided no active support.

University C Executive Commitment

At University C, the project never made it to this stage because a power broker that could get key people to the table was never identified.

Step 5. Gain community support

The last step in alliance formation is gaining the support of stakeholders in the community. The purpose of the community briefing is to gain the support, or understand the opposition of community members capable of influencing the success or failure of the project. Champions identify relevant community members based upon their participation in, or knowledge of, the health care community and local politics. The community members are briefed about the project, attempts are made to address any concerns before the project begins, and support for the project is sought. Again, the meeting is convened by the local champions with the participation and support of members of the initiating organization if appropriate.

Case Study Scenario 5. Gain community support

Health Science Center Community Support

At HSC, the community being targeted was the broader HSC community. An open house was held to celebrate the kick off of the telemedicine alliance with University A. Representatives from the highest level of the institution were involved including representatives from the school of nursing, the department of pediatrics and the Area Health Education Center. Representatives from University A participated in the open house via videoconferencing. The alliance with University B was announced less formally (emails, phone calls, hallway discussions). The broader HSC community was already familiar with the idea of establishing a telemedicine alliance in conjunction with a distance education program. The technology had been in place and was being used by the nursing school for some years now. Anyone affected by the expansion had been involved in discussions prior to the start of the clinic.

University A Community Support

At University A, an evening dinner briefing was held where the dean of nursing/power broker invited primary care practitioners in the community – some of whom cared for children being seen by the pediatric sub-specialist. Key leadership from University A was present to hear community provider's reactions and communicate support for the project.

The community briefing was held after the equipment had been installed. Consequently, the pediatrician was able to attend by videoconference, which saved the physician travel and served to demonstrate the technology to community practitioners. The nurse practitioner that served as the telemedicine clinic manager at the HSC traveled to University A for the briefing.

University B Community Support

At University B, the director of nursing/power broker chose to have the operations

leader/telemedicine clinic manager and the director from the local Area Health Education Center's office visit individually with key practitioners in the community. As with the community briefing at University A, the project was described, questions were answered, and any concerns were relayed back to the director of nursing. All physicians visited were supportive and no further action was needed.

University C Community Support

At University C, this step was never taken. However, regional health system politics played a major role in this project not getting off of the ground. Recall that University C is located in community of 30,000, but a metropolitan area of over 500,000. There are four primary populations centers in the region. Health care competition among these four neighboring communities is intense. Because the region is fairly heavily populated by medically underserved, there was a movement in the region to establish a regional academic health center. All four communities were vying for it to be located in their locale. Compounding the politics, three health science centers in the state were vying for the contract to establish the regional academic health center. The HSC attempting to initiate the telemedicine alliance was one of them. While the telemedicine alliance was being undertaken independently of the regional academic health center initiative, University C and community leaders were suspicious. Attempts to further develop the alliance were postponed indefinitely.

Within a year of implementing the second telemedicine clinic, the HSC and the two universities partnered to expand services to two public schools in each of their service regions (see Table 2). The next year, the HSC and University B partnered again to add mental health, maternal child health and asthma to their activities.

With each expansion, the champion power broker from each of the universities took the lead in developing additional alliances in their regions. As in the initial phase of alliance development, the local champions repeated the Five Step Process. They 1) built upon existing relationships in the schools, 2) identified and developed co-champions within the alliance member organization, 3) engaged a project team – which at a minimum included a technical member along with the schools' co-champions, 4) worked with the co-champions to secure executive commitment, and 5) gained community support. In the project with the schools, community support included parents as well as the health care community.

RESULTS

The Five Step Process (FSP) described in this case study was used to identify and develop strategic alliances for telemedicine among an academic health science center and health professions programs at three universities. Telemedicine services were successfully implemented with two out of the three attempted alliances. The third alliance was never implemented due to the absence of structural mechanisms to support sustainability and lack of strategic alignment between the organizations.

The academic health science center and both alliance members that successfully implemented telemedicine later expanded to include two school systems in each of their regions. The first telemedicine alliance is being sustained, but has not grown since expansion with the schools. The second alliance continues to grow adding mental health, maternal and child health and asthma programs to their activities in 2000 (see Table 2).

All of five steps in the process were carried out with the two alliances that implemented telemedicine. Development of the third alliance were discontinued in Step 2 (develop co-champions) of the process after it became evident that completing Step 4 (secure executive

commitment) and Step 5 (gain community support) was not feasible. The Five Step Process was used again in expanding the alliance to include the local school systems within each of the alliance member's service regions. Each time the process was used, the length of time taken to complete the process was reduced.

DISCUSSION

The Five Step Process is intended to assist program managers in identifying the key players, designing projects, securing resources, and operating and sustaining telemedicine services. Specifically, the process is designed to accomplish two objectives: 1) identify organizations appropriate for exploring a telemedicine alliance and 2) guide the development of alliances that assure ongoing telemedicine utilization and assure long-term sustainability.

The process was used to build strategic alliances between an academic health science center and health professions programs at three universities. The first telemedicine alliance is being sustained, but is not growing. The second alliance continues to grow and thrive. Attempts to develop a third alliance were suspended in during the second step of the process when it became evident that organizational support could not be engendered for the project.

The process was developed between 1992 through 2000 based upon the combined experiences of the authors. Participants of the process conducted this study ex post facto. The authors recognize the potential for bias and misinterpretation inherent in self-studies and ex post facto analyses. However, human factor influences on telemedicine utilization and sustainability are largely unexamined. Self-study and ex post facto analysis have been shown to be useful in understanding complex, interactive, or systemic social phenomena, especially relatively innovative and unstudied topics (19). It is hoped that this case study will be useful in identifying

variables for future study and provide some indication of the nature, strength and direction of relationships among variables (19-21).

In addition, the organizations studied here are an academic health science center and three health professions education programs in university settings. The authors recognize the establishment of telemedicine clinics in the general academic setting rather than more traditional clinical or hospital settings is novel. The study focused on organizations in the southwestern United States in a in rural and smaller metropolitan medical markets. The generalizability of this process to more traditional organizational settings, geographic areas, and medical markets is an open question.

Nevertheless, the literature review below will reveal that many of the principles behind the Five Step Process have been recognized as important to the development of strategic interorganizational relationships.

Theoretical Framework

An amalgamation of concepts from organization (14, 22-24), diffusion (25-27, 29-31), social exchange (2-9) and social stratification theory (2,6, 28) form the underpinnings of the Five Step Process. The concepts of interorganizational relationships, social exchange, intellectual capital, product champions, and socioeconomic status are discussed below.

Interorganizational Relationships

Luker et al. (14) suggest that loosely coupled interorganizational relationships developed for long-term strategic purposes are more likely to be sustained than those created to achieve short-term objectives. They refer to this organizational type as a quasi firm.

Quasi firms, they argue, pursue common strategic objectives with the hope of gaining operational efficiencies, capturing advantages of scale, increasing market share, or to segment

the market. Cordero-Guzman (23) suggests interorganizational relationships may be formed to foster organizational learning, acquire status or legitimacy, provide economic benefits, facilitate the management of resource dependencies, and provide autonomy for employees (24).

Referring to Mintzberg (37), Luker et al. (14) point out that if quasi firms are to function effectively, "they must acquire a capacity for making strategic decisions or, in other terms, they must form a functional strategic apex". Within the framework of the Five Step Process, the operations leader who primarily focused on relationship management among the organizations formed the strategic apex for the telemedicine alliances formed. Luker et al., rightly states that quasi firms require the investment of considerable resources and effort to achieve interorganizational coordination in the pursuit of strategic objectives.

One of the questions this raises is whether the telemedicine coordinating office should serve as the strategic apex for telemedicine alliances. That is, if the telemedicine coordinating office serves as the structural mechanism supporting strategic decision-making, strategy implementation, and boundary maintenance, will the continued functioning of the strategic alliances be insured?

Social Exchange

Hu et al. (7) argues that the motivation for forming intra- and inter-organizational structures in telemedicine can be found in exchange theory. Social exchange theory holds that reciprocity is required to maintain social relationships (2, 6, 23). If resources are not mutually and equitably invested, the relationship is likely to end. Extrinsic (money, goods, services) and intrinsic (reputation, love, honor, duty, beauty) assets are recognized as having value in an exchange (6).

Social exchange theorists recognize actors – individuals, organizations, societies -- are

willing to incur costs and imbalances in their exchange relations when those relations are thought to be long lasting (3, 9). However, mutual trust, understanding and respect are essential to forming long-lasting relationships (23, 24).

Sheppard (32) and Bandura (33) claim that social actors are motivated to commit to a relationship when they perceive that 1) their contributions are identified as being important to the broader community and personally relevant, and 2) there is a clear relationship between contribution and outcome (8). Cordero-Guzman (23) refer to Keyes et al. (34) in arguing that interorganizational relationships are more likely to be sustained when there is a long-term relationship of trust and reciprocity, a shared vision among the organizations, mutual interest in the relationship, and a financial nexus that ties the groups together. Cordero-Guzman (23) found six reasons interorganizational relationships were formed in his study of community-based organizations. First, customer demand for increased services, exchange of expertise, provide additional resources, reduce and/or share costs, increased access to opportunities, enhance visibility and reputation.

Jackson and Clark (21) examined situational and structural characteristics associated with perceived effectiveness. Situational characteristics used included coalition size, coalition type, resource dependence, awareness, consensus, and domain. Structural characteristics included resource flows, formalization, communication frequency, and communication quality. They found the best predictors of perceived effectiveness of collaborations were consensus, formalization of agreements and resource dependence.

Cordero-Guzman (23) suggests the following thirteen factors are associated with successful interorganizational relationships: 1) selection criteria for participation, 2) mutual respect, understanding and trust, 3) inclusive planning process, 4) members with a stake in the

process and outcome, 5) concrete activities requiring joint effort, 6) community involvement, 7) effective consensus-building and conflict resolution strategies, 8) clear roles and policies, 9) open and frequent communication that is both formal and informal, 10) clearly define the service area and population to be served, 11) visible, early successes, 12) concrete, long-term goals and objectives, and 13) exit strategy for handling organizational members that leave.

Intellectual Capital

Coleman (4) introduced the concept of social capital in exchange theory in 1990 (4, 35). According to Coleman, "Social capital...is created when the relations among actors [sic] change in ways that facilitate action". Social capital is often "a by-product of activities engaged in for other purposes". Public goods, which would not be in an actor's self-interest to create, are often created as by-product of relationships entered into because they have direct rewards for the actor.

Taug (10) incorporated social capital into the concept of intellectual capital. He argues intellectual capital includes human capital, relational capital — sometimes referred to as *social capital*, and structural capital. Human capital consists of the "combined skills, experiences, insights and education of organization members". Structural capital is the "procedures, norms, routines and rules that make up the organizational system". Relational capital – or social capital – is the "web of relations between people and groups of people associated with the organization". According to Taug (10), a synergy among two or more intellectual capital resources results in value creation that is greater than the sum of the resources acting alone.

Product Champions

The importance product champions in overcoming barriers and resistance when introducing new products or services into the market has been extensively touted and less often researched (29-31). The role of clinical champions in the adoption and diffusion of telemedicine

has been generally accepted (20, 25). Tanriverdi and Iacono (25) argue that the success of telemedicine programs depends upon a champion's ability to lower technical, economic, organizational, and behavioral barriers.

In a review of literature on champions, Markham and Aiman-Smith (30) found that the majority of projects have champions and a large percentage have multiple. They found product champions are associated with about 80-90% of new product projects. There is a strong positive relationship between project survival and presence of champions. However, product champions do not guarantee market success. Champions support projects when there is a potential benefit to their own department. They may come from any level or functional area of the organization. They materially affect the strategic direction of research and development. They are visionary, calculated, risk-takers that are politically astute and attentive to organizational direction and strategy. They gain organizational support for the project along with commitments of resources, space, and time. They often provoke antagonists that, if embraced, often force the champion to think though the project making it stronger. They are sensitive to organizational politics and are likely to become involved in projects that are innovative. The authors put forth some recommendations for managing champions: 1) work with champions to assure strategic alignment with subunits of the organization as well as the overall institutional mission, 2) encourage champions to become involved in relevant professional communities, 3) seek out an antagonist to balance champion, and 3) provide champions with training and development in managing interpersonal relationships.

Roure (29) studied the influence of product champions' position and seniority in the highly hierarchical organizations of France versus the flat decentralized organizations of Germany. He found that product champions must have considerable power and prestige in highly

hierarchical organizations, but these qualities are less important in flat, decentralized organizations where employees feel close to their superiors.

Reilly et al. (31) suggest the following are desirable personality traits for of champions: openness (unconventional/curios), emotional stability (cohesive; predictable), agreeableness (social interaction; cooperation), conscientiousness (project management; dependable), and extraversion (relationship management).

Socioeconomic Dimensions

Max Weber introduced the three socioeconomic dimensions of money, power, and prestige in his theory of social stratification (2). He argued that these dimensions shape a person's choice of, and approach to, work. Phelan and Link (28) found that financial resources, knowledge, power, prestige, and social connections are among the mix of social factors that shape a person's health.

These dimensions were incorporated into the framework of social exchange theory and used to understand the motivations of various actors (individuals, organizations, communities, society) in developing strategic alliances. Borrowing from Taug (10), the FSP creates a knowledge exchange thereby generating shared intellectual capital.

Adoption and Diffusion

Helitzer et al. (26) rely on Rogers (27) theory of diffusion to outline the necessary convergence of decisions from societal, organizational and individual. Gagnon et al. (18) recognizes the need to explore individual, professional, organizational and contextual dimensions that have influenced the adoption of telehealth in Quebec. Drake (13) reports that the Institute of Medicine report (36) recognizes the need to consider multiple perspectives in assessing the value of telemedicine. These perspectives include clinical, institutional, and system or societal.

Tanriverdi and Iacono (25) recognize the economic (societal), organizational and behavioral (individual) barriers that inhibit the adoption and diffusion of telemedicine.

Future Research and Practice

It is hoped that the Five Step Process, if carried out fully, will lead to the development of strategic telemedicine alliances that result in ongoing utilization and sustainability of telemedicine services. In such alliances, risks will be distributed, resources are shared, and the technology will be used for multiple purposes (administrative, educational, clinical) and across various applications (pediatrics, mental health, asthma). Alliance leadership will understand the risks and opportunities involved, and the people implementing telemedicine will have the resources and commitment to succeed. Whether an individual, organization or community, each actor will understand how telemedicine aligns with respective missions and strategic directions of all of the actors.

Furthermore, this process is not undertaken in isolation of the other **layers of human factor influences** discussed in the editorial commentary of this book (1). Rather, the process is guided by and draws from the various layers of influence. Therefore, it is necessary to explore how the other layers of human factors influence strategic alliance development.

For alliances to be strategic, the **cultural, institutional and professional contexts** of participating organizations must be considered (29). **Technological innovations** may not be appropriate for needs, and when they are, organizational resources must be dedicated and new skills developed (25). **Change management** issues arise with the introduction of technologies and new methods of health care delivery, which have consequences for existing policies, procedures, and work practices throughout participating organizations (25). The **mental model and clinical perspective** of health care professional affect their interest and willingness to

participate in telemedicine (25). They are influenced by organizational incentives or disincentives for participation. Finally, **organizational learning and success** is key to sustaining an initiative as staff turnover and new opportunities arise (25).

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  - Family health condition
  - Professional opportunities
- Organizational
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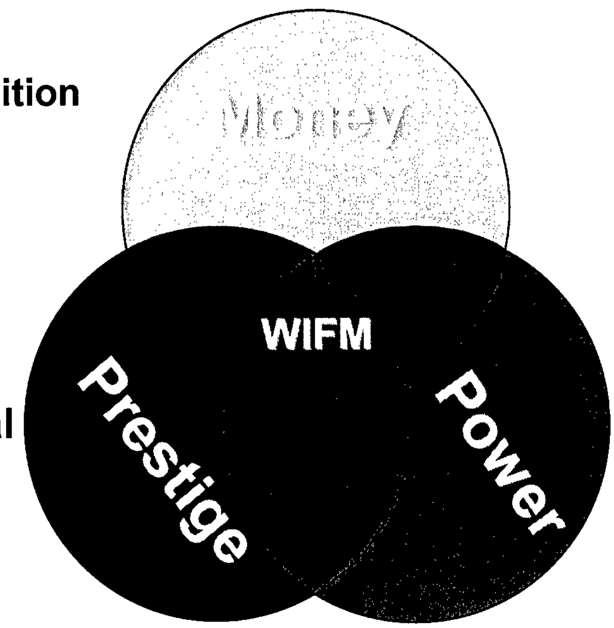
  - non profit?
- Community/ Societal
  - Service or product driven?
  - Altruistic or self-seeking



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Quasi Firms: Strategic Interorganizational Forms in the Health Care Industry

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In response to significant political, governmental, and socioeconomic changes affecting the health care industy, health care organizations are forming a wide variety of loosely coupled interorganizational arrangements. In this article, loosely coupled forms are classified according to the extent to which they are designed to achieve strategic purposes. The quasi firm is defined as a loosely coupled arrangement created to achieve long-lasting and important strategic purposes. Mechanisms that are needed to ensure the continuity of quasi firms are explored, and an agenda for further research is given.

Significant political, socioeconomic, and governmental changes are causing health care organizations to reconfigure and restructure in innovative ways. Some health care organizations have merged with others into tight bureaucratic structures. Others have entered into more loosely coupled multiorganizational arrangements which, although created to function as interdependent wholes, maintain each organization's separate legal identity. These loosely coupled forms are linked in a number of ways, including by subcontracts, leases, interlocking boards, and marketing agreements. The loosely coupled interorganizational forms emerging in the health care industry resemble those commonly found in some industries (e.g., residential construction) and selectively employed in others (e.g., automobile manufacturing and petrochemicals).

In general, existing models of organizational structures inadequately capture the essence of the interorganizational arrangements emerging in the health care and other industries. In this article, a scheme is set forth for classifying interorganizational forms and for identifying a particular type—the quasi firm—that is common in the health care industry. Some of the distinctive features of quasi firms, particularly those characteristics that may be observed in emerging health care quasi firms, are explored. Finally, avenues for further conceptual development and empirical exploration of quasi firms are suggested.

Strategic Purpose and the Emergence of Quasi Firms in Health Care

Historically, informal organizational interdependencies have been a part of the health care delivery system. Health care treatment and patient care systems have required intricate refer-

ral and network arrangements to ensure continuity of care and coordination among hospitals, physicians, support services, third-party payers, and so forth, all of which perform different but interdependent tasks. Historically, organizational and service delivery systems have been designed so that the autonomy of these entities would be preserved.

Recent developments, in combination with the traditional determinants of interdependency among health care organizations, have led health care organizations to consider alternative approaches to achieving organizational consolidation. The passage of Medicare and Medicaid legislation in 1965, heightened market awareness and activity over the last decade on the part of the corporate purchasers of health insurance, and changes in market and financing mechanisms have, together, produced a series of strategic reactions on the part of health care and health insurance organizations. An important early response was the formation of multi-institutional systems in both the hospital and long-term care industries, a strategy driven by a perceived need to capture the operating, purchasing, and market economies attributable to larger organizational scale. This was complemented in more recent years by experimentation with diversification and vertical integration, the latter particularly between hospitals and health insurance companies (Brown & McCool, 1986; Shortell, Wickizer, & Wheeler, 1984).

As health care providers and their organizations have turned to more formally structured relationships, they have been forced to balance shared objectives against the need to preserve highly valued autonomies. This balance has been achieved through a variety of structural compromises, many of which can be described as loosely coupled interorganizational forms.

The diversity of loosely coupled interorganizational forms emerging in the health care field is enormous (D'Aunno & Zuckerman, 1987; Provan, 1984). The arrangements may link together individual health care providers, provider organizations, third-party payers, individual consumers, and/or groups of consumers. These forms, often characterized using simple acronyms, include health maintenance organizations (HMOs), independent practice associations (IPAs), preferred provider organizations (PPOs), alternative health systems (AHSs), third-party associations (TPAs), and medical staff–hospital joint venture companies (MeSHs). Such acronyms, unfortunately, fail to give meaning to the complexity of the emerging health care organizations, and they complicate the search for a clear understanding of their unique organizational features (Luke, 1985).

There are a number of reasons why health care organizations combine into interorganizational arrangements. They may do so to achieve operational efficiencies, to capture the advantages of scale, to increase market share, or to segment the market (Ermann & Gabel, 1984). Perhaps most important are those loosely coupled arrangements that have been created for strategic purposes because these organizations have significantly influenced the competitive structures of both health care and health insurance markets (Arnould & DeBrock, 1986; Goldsmith, 1984). In effect, such loosely coupled organizations function as if they were *firms;* they jointly pursue common strategic objectives in response to market and other stimuli.

Loosely coupled interorganizational forms, many of which are designed for strategic purposes, have been increasingly noted in the literature. For example, Blois (1972, p. 253) discussed situations "where firms gain the advantage of vertical integration without assuming the risks of ownership." Porter (1980) described a series of relationships among independent organizations that are less formal than full ownership, but far more structured than would be found among organizations dealing in the market. Harrigan (1985a, 1985b) and Hayes and Abernathy (1980) noted examples where nonequity arrangements are employed to structure relationships among vertically connected organizations. Thorelli (1986, p. 36) discussed networks of organizations that are intermediate "in terms of

a spectrum of arrangements from loose to tight, from arm's length bargaining to total integration." Ouchi (1984) identified "M-form organizations" in which the formal and informal set of relationships between a group of interdependent firms takes on the characteristics of a clan. In the health care industry, Provan (1984, p. 503) described hospital consortia as "an intermediate step along the continuum ranging from total independence to being part of an owned system." Interestingly, most of these organizational forms have been created as strategic responses to changed market incentives, contingencies, and constraints. Also, most have been formed to serve market functions that are common among more tightly coupled firm structures.

A general concept that can be usefully applied to loosely coupled arrangements that are created to achieve shared strategic purposes was suggested by Eccles (1981a, 1981b) in his analysis of the residential construction industry. Eccles used the concept of the *quasi firm* to describe the relationship between a general contractor and independent subcontractors.

The quasi firm arises in residential construction because of a constellation of contextual and technological conditions, many of which parallel conditions in the health care industry. Home building is characterized by a specialized and autonomous group of workers (representing the various trades), a relatively high degree of task complexity and uncertainty (houses are custom designed and often modified as construction progresses), and site-boundedness (materials are used and work is performed at a specific location). The market for residential housing is primarily local/regional in character, very competitive, and subject to problems associated with increasing resource scarcity. As a result, the industry is comprised of relatively small general contracting firms that maintain a network of stable relationships with a variety of subcontractors. Because of such arrangements, general contractors are able to respond quickly to changing task demands and conditions. Subcontracting preserves the autonomy of skilled workers, a strong tradition in such trades as carpentry, masonry, plumbing, and electrical work. Eccles observed that such arragements tend to be enduring because general contractors come to rely on particular subcontractors, and some maintain such relationships for years (and even decades).

Similarities exist between conditions in the health care and residential construction industries. Health care firms face growing competition, increasingly scarce resources, and high levels of market uncertainty. The provision of personal health care services is site bounded, and it is regional and local in character (Luke & Begun, 1987). The increasing complexity and specialization of technology has necessitated greater interdependence among organizations and professional groups in the production of health care. In addition, these organizations and groups (hospitals, physicians, insurance carriers, and long-term care facilities, to cite only a few examples) possess specialized expertise, differing objectives and value structures, and, traditionally, they have experienced high levels of autonomy.

Eccles' discussion of the quasi firm, although useful for conceptualizing one type of interorganizational arrangement, is limited in its consideration of the distinctions between quasi firms and other loosely coupled firms as well as between quasi firms and more tightly coupled firms. In particular, it does not directly explore the role of strategy in loosely coupled organizations. Therefore, a conceptual scheme that distinguishes among the great variety of interorganizational forms according to the purposes that bring participants together is needed.

Classifying Interorganizational Forms

In order to differentiate interorganizational forms by the degree to which they function as firms, it is essential to distinguish quasi firms from more traditional firms by the *tightness of coupling* that binds collaborating organizations

together. Interorganizational relationships vary significantly by the degree to which interdependent organizations are loosely or tightly coupled (Weick, 1976). Within loosely coupled interorganizational forms there is a minimum of structuring, and common ownership of member organizations is rare. Tightly coupled forms, by contrast, are those in which member units are bound together using more formal structures, and often these include common ownership of those units.

However, going beyond this concept, it is important to consider the degree to which joined organizations serve strategic, versus other less strategic, purposes. Although there are many dimensions along which differences in purpose can be measured, two dimensions highlight the strategic aspects of purpose—the *importance* and *permanence* of a shared interorganizational purpose. First, interorganizational relationships can be differentiated according to how important collaboration is to the survival of each participating organization (Luke & Kurowski, 1983; Morrisey, 1982; Shirley, 1982; Van de Ven, 1976). Differences in importance discriminate between purposes that are strategic (involving high importance) and those that are not (low importance). What constitutes importance, of course, is likely to be highly susceptible to differential perceptions by each organization (as well as by individuals within each organization). A simple indicator of whether a collaborative relationship is important would be the amount of time devoted to building and maintaining collective relationships by the leaders of each collaborating organization. Certainly, an estimate of the financial or competitive impact (measured in terms of expected gains/losses in overall competitive advantage achieved by the collective or the participating organizations relative to their rivals) of a collective effort would be a more direct measure of strategic importance.

A second dimension of strategic purpose is the intended permanence of interorganizational linkages. In order to be truly strategic, a purpose must have long-term reach. Short-term objectives (implying less permanent linkages) are, by definition, not strategic (Shirley, 1982). Relative to the importance dimension, the anticipated permanence of an interorganizational relationship should be relatively easy to establish. It should be noted, however, that permanence is a dimension of purpose but not of the interoganizational structure per se. The actual achievement of permanence depends on many factors, not the least of which is an intention for a relationship to be permanent.

In sum, intended permanence and perceived high importance constitute two necessary conditions for the purposes of interorganizational relationships to be strategic. Further, strategic purpose in combination with the tightness of interorganizational coupling are essential dimensions for differentiating among interorganizational forms that function as firms and those that do not. We have combined these two dimensions to form a classification of interorganizational relationships, which is depicted in Figure 1. The classification scheme also distinguishes the *quasi firm* from other loosely coupled interorganizational forms. As indicated in Figure 1, tightly coupled organizations are classified as either firms or "latent" firms, depending on the degree to which strategic purpose is primary in determining the firm's viability. Latent firms include those tightly coupled organizations that, because of a lack of stimulation in the external environment (e.g., they are natural monopolies) or because of their distinctive, often governmental, roles in society, are not primarily driven by strategic purposes. This could include a number of organizational types, including, for example, large public utilities, the postal system, police systems, schools, park management organizations, and some other service organizations. (For a discussion of such organizational types as well as their unique behaviors, given their distinctive environmental circumstances, see Lawrence & Dyer, 1983.)

Similarly, loosely coupled organizations are

classified in Figure 1 as either quasi firms or networks, again depending on the degree to which strategic purposes are the basis of the collective effort. A network could be formed between any two or more organizations that collaborate on activities that are not sufficiently important or long term to be considered strategic. Likewise, a quasi firm could be formed when the purposes are more important to the collaborating organizations and are intended to be permanent.

Given the above, we can now define the quasi firm as a loosely coupled, enduring set of interorganizational relationships that are designed to achieve purposes of substantial importance to the viability of participating members. Such an arrangement effectively functions as a *firm* that is absent the characteristic of ownership and many formal administrative structures.

Creating and Maintaining the Quasi Firm

The quasi firm represents a critically important category of interorganizational arrangements. The formation of a quasi firm, for example, may represent a viable alternative approach for entry into new markets. Quasi firms may well facilitate more rapid and less risky entry (and exit) than would acquisition or internal expansion strategies. This is true because only limited amounts of capital are required to establish quasi firms when compared to what would be needed if more tightly coupled structures would be created (either through acquisition or internal expansion). In the health care field, for example, a major commercial insurance company could, during a matter of months, establish the necessary contractual relationships with selected physicians and hospitals that would be needed to offer an HMO to a local market. Entry through acquisition would require immense amounts of capital, and it would entail enormous amounts of time to achieve agreement, assuming, of course, that local providers could be acquired. This may account for the growing popularity, on the part of commerical insurance companies (that are seeking entry into many markets) and many other health insurance or health delivery organizations, of PPO and IPA insurance/delivery modes over the more tightly coupled closed panel or group model HMOs.

		TIGHTNESS OF COUPLING: High	Low
DEGREE OF STRATEGIC PURPOSE	High	Firm	QUASI FIRM
	Low	Latent Firm	Network

Figure 1. The quasi firm as a specific form of loosely coupled interorganizational relationships characterized by high strategic purpose.

Other possible strategic advantages of the quasi-firm configuration include efficiencies of increased scale and scope, increased market share, and gains in legitimacy for some participants. Many of the potential advantages of the quasi firm, however, may not be realized because of the strategic inflexibility inherent in the structure of the quasi firm (Bresser & Harl, 1986). The ability to manuever quickly in response to environmental change requires that quasi firms establish long-run stability and appropriate mechanisms for decision making—operational issues to which we now turn.

Stability of the Quasi Firm

The "firm" status of the quasi firm introduces a number of important consequences unlikely to be experienced by either the less strategically oriented, loosely coupled networks or the more bureaucratically structured firms. By sharing in the important and permanent strategic purposes of a quasi firm, participating organizations intertwine their individual destinies to such a degree that powerful forces endogenous to the quasi firm, either convergent or divergent, could seriously complicate attempts to reconcile conflicting objectives. Giddens (1979) suggested that

convergent and divergent forces are separate but complimentary determinants of a continual pattern of restructuring within organizations, and Fombrun (1986) explored the structural dynamics of such forces within and between organizations. Both recognized that organizational restructuring is an ongoing response to the diversity of forces for change. In quasi firms, such forces could, indeed, put into jeopardy the delicate balance inherent in their loosely coupled interorganizational structures.

Divergent forces are likely to be "explosive" within quasi firms because they have the potential to unravel the loose, and relatively unstable, structures of quasi firms. Individual organizational participants, for example, could hold vastly different assessments of the probable contribution that the collective effort will make to the long-run viability of their own organizations. Thus, ultimately, they might differ significantly in their willingness to assume the risks of collective behavior and, in time, to continue participating in the quasi firm. Convergent forces, by contrast, are "implosive" because they could precipitate increasing formalization of the quasi firm's structure. This may be especially true for those quasi firms located in environments that are relatively uncertain and unstable. Loose coupling, for example, may provide insufficient cohesiveness within collective organizations for timely strategic decisions to be made in response to a changing environment (Bresser & Harl, 1986). Thus, powerful and simultaneous divergent and convergent forces have the potential for producing major structural change within quasi firms during a relatively short span of time.

Mechanisms for Strategic Decision Making

In effect, the quasi firm may be an inherently unstable organizational form. Thus, in order for quasi firms to continue to function as loosely coupled organizations, they may need selected structural features that facilitate the making and implementation of strategy. Among these features, three are particularly important. Quasi firms will need to develop mechanisms for (a) making strategic decisons, (b) ensuring a unity of effort among collaborating organizations, and (c) determining and modifying membership in, and establishing the boundaries of, the quasi firm as it evolves over time.

If quasi firms are to function effectively as firms, they must acquire a capacity for making strategic decisions or, in other terms, they must form a functional strategic apex (Mintzberg, 1979). By definition, a quasi firm utilizes loose coupling in order to achieve strategic coordination among collaborating organizations. In unstable and unpredictable environments (which currently exist in many sectors of the health care industry), strategic decisions inevitably will need to be modified, often within short periods of time (Ansoff, 1979). Thus, for such organizations, we can expect that the pursuit of strategic consensus will consume significant amounts of organizational energy (Quinn, 1980). Under such circumstances, a quasi firm could easily become impaired should it not evolve a functional capacity or mechanism for making and implementing strategic decisions. (Alternatively, the need to formalize decision-making mechanisms may be far less pressing in arrangements that have been organized to accomplish less important and/or permanent shared purposes [i.e., in networks] because collaborating organizations in such arrangements have less time, energy, and so forth, invested in collective behaviors.)

Where the capacity for making strategic decisions, the strategic apex, should be located within a quasi firm is problematic. We suggest that such location will in part be determined by the direction of linkages that exist among the participating organizations. Interorganizational relationships can be horizontal (across markets), vertical (along the production chain), symbiotic (across products/industries), or any combination of these (Ansoff, 1965; Astley & Fombrun, 1983; Pennings, 1981; Porter, 1980). The strategic apex of a quasi firm, for example, is likely to be most

centralized within a single organization in vertically linked collectives, relative to what might be expected in symbiotic and horizontal collectives. In vertical systems, strategic decisions depend heavily on actions taken in the markets in which the most downstream firms operate. Thus, in vertically structured quasi firms, leadership in strategic decision making may naturally evolve to the organization within the vertical chain located most closely to the final consumer. In residential construction quasi firms, for example, strategic decision-making mechanisms may not even need to be formalized because making strategic decisions is the role appropriately assumed by general contracting firms (perhaps accounting for the exclusion of this subject in Eccles' work), the most downstream organizations in the residential construction vertical structures. It is less likely, however, that any one organization will be in a position to assume strategic leadership in dominantly horizontal or symbiotic linked quasi firms. As a consequence, because interorganizational compromises are required in order that important and permanent decisions can be made, the creation of a strategic decision-making capacity should for the latter types of organizations be more of a challenge.

A strategic decision-making capability is only one of the firm-like attributes a quasi firm must adopt in order for it to continue functioning. Mechanisms for implementing quasi-firm strategy must also exist. The members of each participating organization, not just the leadership, must be aware of, and committed to, the quasi firm's strategic goals. This requires that management pay attention to creating an identity, a culture, and an information flow that crosses organizational boundaries. In doing so, quasi firms may need to invest considerable effort and resources in order to achieve interorganizational coordination in the pursuit of strategic objectives.

Just as we argued for the design of a strategic apex, mechanisms that are created to support the implementation of quasi-firm strategy will vary substantially, depending on whether vertical, horizontal, or symbiotic structures are predominant. The specific mechanisms needed, the degree to which they are centralized in a collective, and the intensiveness of monitoring and/or coordinating activities will be determined by the direction of the relationships among member organizations. For example, if the organizations in horizontal quasi firms share common markets (i.e., they would be competitors if they were not coparticipants), more intensive efforts might be needed, when compared to organizations in which less competitive horizontal relationships are involved, to ensure a continuing culture of group interest and compliance with the collective's strategy. In quasi firms that are dominated by vertical linkages, a single organization could, perhaps, more readily be designated the coordinative role (e.g., as played by general contractor firms in residential construction quasi firms).

The existence of multiple interorganizational relationships introduces another problem for the quasi firm: determining its membership or, in other terms, specifying its outer boundaries (Laumann, Galaskiewicz, & Marsden, 1978). Identifying boundaries for firms may be particularly challenging in the health care field because of the complexity of interorganizational arrangements and the loose coupling that is frequently used to achieve interorganizational coordination. Some organizations in a loosely coupled firm may be heavily invested in shared strategic purpose, whereas others may have only limited dependency, and the number of the latter could be substantial for some collective organizations. One could argue, however, that the boundary of the quasi firm should only be drawn around those organizations for which the collective serves a significant and long-term strategic purpose. Organizations with limited dependencies would, in this case, not be counted members of the quasi firm.

The redrawing of boundaries over time,

though difficult, should be an important task for the quasi firm, especially if it hopes to maintain its stability over time. Rigidities introduced by heavy reliance on prior agreements to regulate collective membership and the distribution of both effort and profits/losses are likely to introduce significant complications for quasi firms as they grow and develop. The existence of hangers-on and/or collaborating organizations that are not rewarded commensurate with their relative contributions certainly will introduce pressures for a realignment of membership and the drawing up of new rules that govern participation. Thus, it is likely that mechanisms for accomplishing necessary restructuring of boundaries and conditions for membership will be essential for ensuring the survival of quasi firms.

Research Agenda

A significant agenda for research is suggested by application of the concept of loose coupling in general and the quasi firm in particular to the investigation of interorganizational relationships. Such applications focus greater attention on interorganizational relationships that are designed to achieve strategic purposes, an area in which both conceptual and empirical work is lacking.

A future research agenda could be organized around four general areas: (a) further delineation of the quasi-firm concept, (b) conditions explaining the frequency of quasi firms in different environments and industries, (c) identification of the structural mechanisms that are necessary for the functioning of the quasi firm, and (d) evaluation of the performance of quasi firms.

We have proposed that quasi firms are distinguishable by the importance and permanence of their strategic purposes and the loose coupling that ties the collaborating organizations together. This scheme for classifying interorganizational forms includes only a few of the possible dimensions along which such systems might be classified. Organizations exchange many different types of resources (e.g., financial, human, and technological), for which different kinds of interorganizational structures may be needed. It could be hypothesized, for example, that quasi firms are more likely be used when financial resources become the primary medium of exchange, as is now often the case in the health care industry. Research is needed in order to assess the utility of the dimensions proposed here and by others that may provide insight into the great variety of loosely coupled organizational forms. In this effort, the recent work on the measurement of interdependence within organizations would be pertinent (Victor & Blackburn, 1987).

A second general area for future research is the identification of conditions under which quasi firms are found in significant numbers. As initially argued by Eccles, for example, when production is site bounded and requires the cooperation of autonomous or semiautonomous units, the quasi firm may be an appropriate organizational form. In their study of American industries, Lawrence and Dyer (1983) conceptualized the environmental conditions that are likely to produce differential strategic and structural responses by firms within industries. They also considered the circumstances under which quasi firms might be expected to evolve. We have suggested that loosely coupled relationships in general and quasi firms in particular may be effective interorganizational arrangements in selected industries that are undergoing rapid environmental change.

Third, it is important to determine the kinds of structural mechanisms that are needed to ensure the continued functioning of the quasi firm in the face of uncertainty and environmental change. We have proposed that quasi firms will need to create mechanisms for strategic decision making, strategy implementation, and boundary maintenance. The degree to which these are created as quasi firms evolve should be examined empirically. In his discussion of the quasi firm in the residential construction indus-

try, Eccles (1981a) did not examine these critical issues. We have suggested that this could be explained by a possibly unique feature of vertically structured quasi firms (which are predominant in the residential construction industry): the natural tendency for the most downstream organizations within the structure to assume strategic decision-making and coordinative responsibilites. Which organizations might take the lead or how strategic decisions would be made, however, is problematic in other industries in which a variety and mix of directions in interorganizational linkages are present.

In some cases, the strategic apex, as well as the other structural features needed to ensure long-term stability, may emerge naturally as a function of the technology of production or some other environmental/organizational factors. In other cases, it is likely that strategic leadership would be negotiated and some structures for sharing in and implementing strategic decisions would be created. In the latter cases, negotiations may require considerable organizational compromise, adding significantly to the instability of the quasi firm organizational form.

A final area of research involves the performance of quasi firms. It is unclear how well quasi firms perform as strategic entities. We can only speculate on their relative strategic advantages and disadvantages. We have argued, for example, that quasi firms represent relatively efficient entry mechanisms for otherwise uncoordinated and small-scale organizations. However, do they possess the same advantages in overcoming mobility barriers, for pursuing low-cost strategies in their markets, or for achieving needed product differentiation? Although they might strengthen the competitive position of organizations in given markets, will they facilitate the formulation and implementation of a diversified corporate strategy? Further, in keeping with Bresser and Harl's thinking (1986), will quasi firms impede the strategic flexibility of member organizations?

A critical feature affecting the performance of quasi firms is their stability over time. It is important to determine, for example, how stable the quasi firm is, given the countervailing pressures for convergence and divergence that exist when two or more organizations combine in the pursuit of significant strategic purposes. To what extent are quasi firms merely stages in an evolving process from market-based to more bureaucratic structures, as suggested by D'Aunno and Zuckerman's (1987) study of one form of health care network?

Alternatives to bureaucratic forms should be given more prominence in both theory building and empirical research. Loosely coupled structures have become exceedingly important in the health care industry and occur with great frequency in other industries (e.g., automobile manufacturing and petrochemicals). Further exploration of loosely coupled interorganizational forms, especially those created to serve strategic purposes, will broaden our understanding of the incredible diversity of organizational responses to different market and technological conditions.

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Section 6: Mental Models and the Clinical Perspective in e-Health

Telemedicine in Emergencies

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This article reviews the human factors associated with real-time, distributed medical decision-making, the telecommunication mode that is likely to occur in wartime or other emergency states. We address two questions, one general to distributed decision making, the other specific to medical application of real-time decision-making using telecommunication technology in emergencies. The objectives of describing real-time distributed medical decision-making are to: characterize the relative importance and priority of certain medical information for remote decision-making: to assess the impact of domain expertise (surgeons, anesthesiologists, nurses) on information-gathering and data interpretation; to determine how medical performance could be evaluated or mentored remotely and identify uncertainties among remote decision-makers viewing events through multimedia telecommunication links; to make recommendations that have implications for the design of medical telecommunications in support of real-time distributed decision-making.

Moray has suggested that causes and effects of errors in a system should start with steps that reduce and control the local issue of the workspace layout and ergonomics before tackling more complex and difficult-to-correct issues since as individual and team behaviors. Similarly with telemedicine, the correct images from the observation points must be used with optimal recording of verbalizations before being able to assess individual and team performance. Organizational, legal, societal and cultural pressures are the outer layer of Moray's onion model[1]. This book is designed to present each layer of this onion and to examine its interrelationship with all the other layers.

1.1 REVIEW OF DISTRIBUTED DECISION-MAKING

Telemedicine provides or supports clinical care at a distance from the provider who is co-located with the patient, by use of electronic communication and information. The provision and support of clinical care is achieved through audio, data and imagery transfer between the co-located provider and the remotely situated provider or supporter of clinical decision-making. How distance impacts the abilities of the remotely situated clinical decision-maker to perceive the same cues, and understand the dynamics and coordination of the co-located providers is unclear. The effects of distance on performance of widely distributed decision-making is of importance for situations, such as wartime, disasters, chemical or biologic weapons attack, when dynamic real-time decision-making about medical triage, resource management and coordination of rescue efforts (for example, military, fire, EMS) will be needed. This review of the background of distributed decision-making considers the situation when telecommunications will be used dynamically, for remote emergency medical decision-making. We believe that in the future, real time telemedicine communication links will be used for monitoring medical performance, just-in-time training, task-specific telementoring as well as coordination of medical responses (in the broadest sense, for example, triage, resource management, etc.) in wartime, disasters, chemical and biologic attack and other emergencies.

Such distributed decision making is a research paradigm for understanding organizational, group, and decision making when members are distributed in several senses including: physical location, access to information, authority, expertise and access to resources. Field military medicine missions in wartime, in disasters or secondary to terrorist activity are prime examples of distributed decision making, as collaborating members are distributed in all of these five senses. Telecommunication advances in recent decades have overcome many of the technical barriers to communication over distance and time. Increasingly telecommunication systems have become an integral part of many professions, enabling remotely located individuals to collaborate on problem-solving with expertise unavailable locally. Yet our understanding of how people work together when using communication technologies has been lacking[2,3,4]. Interesting and challenging research issues arise and surprising uses of telecommunication systems for medical decision-making and problem solving occur. For example, the agent used in the Sarin attack in the Tokyo subway, was diagnosed by a Japanese physician with knowledge of previous organophosphorous poisonings, seeing the poisoned victims' responses on television news coverage. Telecommunication advances enable remotely situated individuals to collaborate on problem solving with expertise that is not available locally.

Communication and Shared Mental Models

Lack of a shared situational awareness is one of the difficulties in using telemedicine communications to facilitate provision of, or support for, clinical care from a distance. Medical providers co-located with the patient share information through many verbal and non-verbal means. These medical providers have often worked together previously and they know the domain and the context of the current situation, whereas, remotely situated decision-makers are very unlikely to have trained with the co-located providers or know them, because they may be making the telemedicine communications to this location for the first time. How such remotely situated experts can rapidly get up to the same, or an acceptable level, of understanding to communicate and coordinate activities with the co-located care providers, remains uncertain. In order to understand how this can best be achieved from a distance, we first need to understand how such communication and coordination occurs among co-located medical care providers.

The shared mental model[5,6] is an emerging concept to capture how co-located members of a team could function together, often with little overt communication. The underlying assumptions are that team members, through training, experience and communication, achieve congruent mental models of the current situation, choices available, relevant goals, and future steps. Xiao et al[7,8] described several ways in which co-located medical team members were able to coordinate without explicit communication. Serfaty et al[9] described the effect of workload on communication processes. Under high workload, team members adopt strategies that reduced the need for explicit communications.

These studies all demonstrate that in highly trained teams with experienced members, communication patterns varied and there are ways for leaders to exert

influence without explicit communication. In contrast to many previous studies on leadership, verbal activities are usually the only ways in which leaders function. Such difference would have direct bearing on the potential impact of new communication technologies on leadership.

Verbal communications have often been studied as the major form of coordination process[10]. The concept of "implicit coordination" was introduced when teams were found to be able to coordinate with reduced communications[9], especially under high workload situations. To investigate factors promoting implicit coordination, it has been hypothesized that "shared mental models", or **shared** understanding of goals and tasks, is a key, since division of labor in most work settings may have prevented team members from understanding other people's tasks. Volpe et al[11] tested this hypothesis and found that cross training, in which team members were trained in other people's tasks, improved team performance by prompting implicit coordination. The concepts of shared mental models and implicit coordination and related empirical data highlight the issue of communication cost. When workload and time pressure is high, reducing the cost or workload related to communication has obvious advantages[12]. If it is important for team members to share an understanding of each other's tasks and goals, which are relatively stable, it is equally important for team members to be aware of task situations and each other's activities, plans and work focus, all of which are changing in dynamic work settings.

1.2 REAL-TIME TELEMEDICINE DISTRIBUTED DECISION-MAKING IN WARTIME OR OTHER EMERGENCY STATES

In the current military, the remote teleconsultant does not give medical direction – the "guy-on-the-ground" is in charge. However, future military doctrine may change to enable telemedicine communications to be used for real-time telementoring and just-in-time training and decision-aiding for emergency responses to disasters, chemical or biologic weapon deployment, other terrorist attacks and war. To assess the needs of telemedicine in such situations, we explored the cognitive demands and information use of decision-makers in emergency, real-time, medical diagnosis and treatment. Existing videotapes of real trauma patient resuscitation and management at the Shock Trauma Center were used as the stimulus material to recreate dynamic decision-making situations where the impact of the telecommunication media on situational awareness and remote decision-making could be determined. There are clearly differences between the military medicine mission environment and a trauma center, but there are similarities in that emergency life-saving medical interventions occur that could potentially be telementored by remotely situated experts[13]. There can be physical deterioration of the field military team members due to fatigue or injury. In the field, unlike the trauma center, there are finite supplies and limited and fixed resources. As a result, there are limited options available to deal with unanticipated events. However, using audio/video records of human processes in real life trauma patient resuscitation as surrogate material allows testing the understanding of decision making by remote experts, and examining how these experts view the multidisciplinary teams' function in dynamic and stressful situations. In addition, we used such an approach to identify the information that remote decision-makers can extract from audio/video records.

For acute events, human factor resemblances between team members in a military medicine mission and a multidisciplinary trauma resuscitation team are quite strong[14]. The military medicine team has to deal with both the enemy and with many complex and interacting systems within their team. They are required to understand system data in stressful conditions when their capabilities for comprehension can be overloaded with a multitude of signals whose priorities for attention may be ambiguous. During prolonged medical missions, the changing emotions of military team members and anxieties associated with specific tasks or being under enemy attack may result in impairment of decision-making and problem solving. Interactions with an expert, but remotely distributed colleague may be able to modulate such stressors and anxieties by providing psychological support and allowing maintenance of cognitive performance.

There is relevance of trauma patient resuscitation to military medical missions for acute events, because of performance shaping factor resemblances between military medicine and a multidisciplinary trauma resuscitation team. The domain of trauma patient resuscitation is high risk; tasks may need to be carried out under severe time pressure with many additional stressors, including noise and uncertainty. The trauma patient resuscitation area (13 feet x 12 feet) is space-limited like military wartime resuscitation areas, so allowing activity monitoring of other care providers and a shared event space. The trauma team, like the military team, has specific domain-expertise. In both trauma resuscitation and in military missions, there is a need for a widely shared mental model that allows for diverse, often non-routine decisions to be made with imperfect information. Both the trauma team and military team members have to maintain cognitive performance despite physiological stressors (such as sleep deprivation), and emotional disturbances. For the trauma team, this includes dealing with combative and abusive patients and those with severe injuries.

Like military missions in wartime there are many uncertainties confronting the trauma team decision-makers. There are unknowns about the emergency patient (site and extent of intracerebral, thoracic and abdominal injury, past medical history in unconscious patients), and because emergencies are unpredictable, the incoming patient workload is unpredictable. In an analysis of the impact of uncertainty on trauma team performance[15], In 40 patient resuscitations, we found patient related and team/organization related uncertainties. In acute events, similar uncertainties will probably exist for the on-site field military medicine team.

Generalizability of Findings to Military Medicine Missions

The domain of trauma resuscitation was used as a "laboratory" to develop and test general characteristics of how remotely situated decision-makers understand events in dynamic domains such as are present during wartime, in disasters, and chemical or biologic attack with weapons of mass destruction. Although the domain of trauma resuscitation is a highly specialized medical domain, it shares many similarities with military medicine missions as described above. In order to understand how real teams function in real, stressful situations, the "laboratory" we studied can be a valuable surrogate to provide insight into the medical environment that might occur

in war and other emergencies. We paid special attention to the underlying theoretical concepts, such as task urgency, and uncertainty so that our results can be generalizable.

These data yield insights into the cognitive processes involved in skilled performance and decision-making, during distributed decision-making in trauma resuscitation. They have interest to the military and the medical community because urgent diagnosis and treatment of medical problems and coordination of medical resources by telecommunication links will need to occur in wartime, disasters and as a result of chemical or biological attack with weapons of mass destruction.

Our previous findings[14] suggest the possibility that the involvement of a remote expert, depending upon the information available to him/her, may assist the on-site team in avoiding certain pitfalls. For example, some errors in this task environment have been attributed to the team fixating inappropriately on suspected instrumentation problems, at the expense of continued observation and physical examination of the patient[8]. A remotely located expert might be less prone to being caught up in such inappropriate allocations of collective attention. Trauma teams functioning in high stress, emergency cases have been shown to take procedural short cuts, which can be counterproductive, e.g., failing to make use of available instrumentation. Remote experts, to the extent that they retain a "big picture" perspective of the case, might more readily detect procedural oversights or other errors that are due to the stress of the moment rather than to lack of knowledge. Likewise, it may be easier for the more detached, remotely located expert to focus on trends in patient vital signs, and to formulate diagnostic conclusions there while the on-site decision-maker may be burdened with concurrent tasks to the extent that he/she only has the working memory capacity to monitor moment to moment.

1.3 RESEARCH EFFORT QUESTIONS FOR DISTRIBUTED DECISION MAKING

This effort addresses two research questions, one general to distributed decision making and the other specific to medical applications of dynamic distributed decision making, such as would occur during wartime or other emergencies, e.g., disasters, chemical or biological attack with weapons of mass destruction.

As a first general question, the effort was directed at answering the question, what information is used by a remote decision-maker? For a decision-maker to effectively participate in a decision making process, a prerequisite is to be able to assess the situation and problems at hand. In a distributed decision making context, this requirement means that the decision maker has to rely on telecommunication links (e.g. computer, telephone, and video networks) to achieve situation assessment and to understand problems to be tackled. This requirement may be fulfilled relatively easily when events evolve slowly, but it can be difficult to satisfy when situations change rapidly[16]. Little empirical data have been reported on how people can assess dynamically changing situations and problems through telecommunication links. Therefore, there is little empirical basis existing to guide the design of telecommunication systems in support of distributed decision-making.

A second question, specific to medical applications of distributed decision-making is also addressed: how should we make use of remote expertise? This question is related to a broadly defined field of telemedicine. With the development of technologies, many of the long-time desires of medical practice seem to come true: the physicians can see and talk to the patient over long distances, physicians themselves can use video teleconferences to save travel costs. Much of the efforts on telemedicine have been driven by technology and have been based on untested assumptions about the impact of technology. As evidenced in the research on the impact of technology and on the use of video teleconferencing systems in organizations[17], each use of technology is an experimentation with unexpected outcomes and it creates a new work environment with new tasks and requirements. New modes of errors and new patterns of workload will result when technology is deployed, sometimes seemingly innocently replacing or automating a component in the work environment.

It is unclear what information a remote medical decision-maker requires to management of medical emergencies and how effective remote management is at producing appropriate and timely diagnosis and management of humans with medical problems. It is also not known how different types of medical subject matter experts (surgeons, anesthesiologists, nurses) function as independent remote decision-makers and thirdly, how the response of the on-site trauma patient managers affects the remote decision-maker is also uncertain.
As a preliminary step to address these research questions, our project examined the ability of trauma experts to remotely manage trauma patients through telecommunication links, and identify how telecommunication systems should be designed to facilitate such tasks. Important features of the domain of trauma patient resuscitation are that the patient's condition changes rapidly and is often uncertain, and that the resuscitation effort is carried out by a multi-disciplinary team. Apart from being used as a research "laboratory", trauma patient resuscitation could benefit from telecommunication because in many situations injured patients are spatially remote from expert care providers.

Specific Aims

We used our existing videotapes and database (see below-under video library) including transcriptions of reviews of the management by participant and non-participant subject matter experts (SME's) and summaries of diagnostic and surgical findings and laboratory and radiological data[18]. From these data, we examined the following specific aims:

Specific Aim 1: Characterize the importance of various information-providing factors in remote decision-making for the emergency management of the trauma patient. These results would address questions about the relative importance of patient vital signs (heart rate, blood pressure, oxygen saturation, etc.), and physical examination in determining appropriate emergency medical management of the trauma patient.

Specific Aim 2: Assess the effects of different types of subject matter experts (surgeons, anesthesiologist, trauma nurse) functioning independently as the remote decision-makers. This specific aim would examine how strategies of information-gathering data interpretation and integration differ among medical subject matter experts working independently.

Specific Aim 3: Determine how team coordination and breakdowns in coordination might impact on the decision-making of a remote expert and to identify what remote experts were uncertain about when viewing events through multimedia telecommunication links.

The studies were carried out by the National Study Center for Trauma and EMS investigators working at the R Adams Cowley Shock Trauma Center of the University of Maryland. This facility is a Level One trauma center that is regarded as one of the pre-eminent facilities of its kind in the world and is the Primary Adult Resource Center for the State of Maryland trauma system. As such, it serves as a training ground for trauma anesthesiology and surgery residents and faculty from all over the world.

Video Library

Audio/videotapes in the library were earlier developed in this real Shock Trauma environment under a grant funded by the Office of Naval Research (ONR#N00014-91-J-1540) and supplemented by video clips as a result of other funding sources (NASA grant #NCC2-921, ARI Grant # DASW01-99-K003 and AHRQ grant # U18HS-11279-01).

A unique feature of the video recordings was that the video images contained overlaid patient vital signs (Figure 1). The images in the video-acquisition systems network (VASNET) are overlaid with patient vital signs obtained from a serial interface on the patient's monitors[19]. These vital signs are essential to understanding of the decision-making process of the Resuscitation Team. They include heart rate, oxygen levels in the patient's blood (SpO_2), measures of ventilation (end-tidal CO_2) and blood pressure, temperature and filling pressures of the heart. Such a recording method makes video analysis efficient as trauma resuscitation activities are initially guided by the goals of diagnosis of the causes of abnormality in the vital signs and normalization of vital signs.

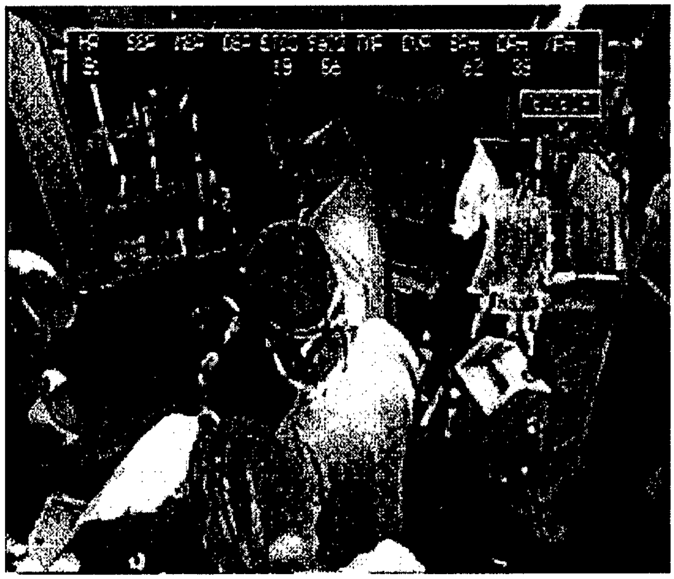

Figure 1. *Video image of trauma patient resuscitation. This patient had a flail chest and major intra-abdominal bleeding. Vital signs show heart rate (HR) 91/min on extreme left. End-tidal CO_2= 19 mmHg, O_2 saturation = 86%, and non-invasive BP = 62/39 shown on the right side of overlay. Time code is shown beneath BP.*

The audio/video acquisition system has been in operational use for more than eleven years and it is reliable and easy to use. Our research team established rapport among the care providers in the Trauma Center for audio-video taping. The system is turnkey operated and we believe this does not interfere with patient care, nor does the videotaping from cameras affixed to the ceiling appear to influence the behavioral aspects of the trauma team. The trauma team members expressed their lack of remembrance that they were being videotaped on review of the events. Rather, they were concentrating on the tasks at hand. One of the useful parts of videotape review was that the participants noted events that during resuscitation they had not recognized because of their selective attention to other aspects of care.

Using the VASNET system, we have established a video library of team performance during trauma patient resuscitation. The video library contains over 200 cases of real trauma patient resuscitation. These existing videotapes and other materials were used as stimulus material in this study of distributed decision-making. Aside from video and audio recordings, medical records (e.g. patient admission records, anesthetic and surgical records, discharge summary, vital signs, and blood chemistry) were also collected. After patient identifiers were removed, these were copied and became part of the database. A majority of these cases were reviewed by subject matter experts, both neutral (i.e. not in the recorded cases) and participant (i.e. in the recorded cases). It was this database that was used to examine the three specific aims.

1.4 EXPERIMENTS ON REAL-TIME DISTRIBUTED DECISION MAKING IN EMERGENCIES GENERAL METHODOLOGY

The general methodology adopted in the experimentation was to present the subjects with video segments of real-life trauma patient resuscitation from our video library. The subject's ability to assess the status of the patient and the progress of the resuscitation effort was then measured. Experiment subjects were all subject matter experts (SME's). The video presentation was to **simulate** remote diagnosis through telecommunication in which experts would be provided with live video images. Patient history on admission to the Shock Trauma Center was given to the SME's at the start of each experiment. During the course of the presentation of the stimulus materials, stop points were inserted, at which the subjects filled in questionnaires specially designed to capture their understanding of patient status and resuscitation activities contained in the stimulus materials. The questionnaire contained open questions and was generic (i.e. same across all stop points and not case-specific)[20].

Stop points were chosen in each case segments based on the stages in the resuscitation effort. For each stop point, 1-3 items of descriptions were generated based on the analysis results to represent the ideal understanding of the status of the patient and of the resuscitation activities, and these items were used to score the questionnaires filled by the subjects (Table 1.1). Thus even though questionnaires were generic, the scoring items were dependent on the specific stop point (see Table 1.2).

Four case segments (5-8 minutes each) were used in the experiment; with 3-4 stop points in each case segment. These case segments were selected to represent a wide range of trauma patient resuscitation scenarios, and they were relatively complex.

1	I would describe the current patient status as (list up to 5 most important descriptors, in the order of decreasing importance)
	The following is unclear to me (list up to 3 most important, specific areas, in the order of decreasing importance)
2	I would describe the current team activities as (list up to 3 most important descriptors, in the order of decreasing importance)
	The following is unclear to me (list up to 3 most important, specific areas, in the order of decreasing importance)
3	I would describe the decisions just made by the team as (list up to 3 most important decisions, in the order of decreasing importance)
	The following is unclear to me (list up to 3 most important, specific areas, in the order of decreasing importance)
4	The team at the moment should consider the following differential diagnoses (list up to 5 most important differential diagnoses, in the order of decreasing importance)
	The following is unclear to me (list up to 3 most important, specific areas, in the order of decreasing importance)
5	I am anticipating the following immediate patient problems (list up to 3 most important, specific problems, in the order of decreasing importance)
6	List, in priority order, three most important objectives of the team and the instructions you would give to achieve the objectives.
7	List, in priority order, three decisions that the team could be making next.
8	List, in priority order, three most important pieces of information you would like to obtain, and the reasons why you need them.
9	Please rate your responses to the following statements on the five-point scale: • I am comfortable to giving instructions to the team. • Given the opportunity, I would obtain more information. • I know the tasks being carried out by the team.

Table 1.1. Questions in the questionnaire used in the experiment to measure the subjects' understanding of remote events and activities.

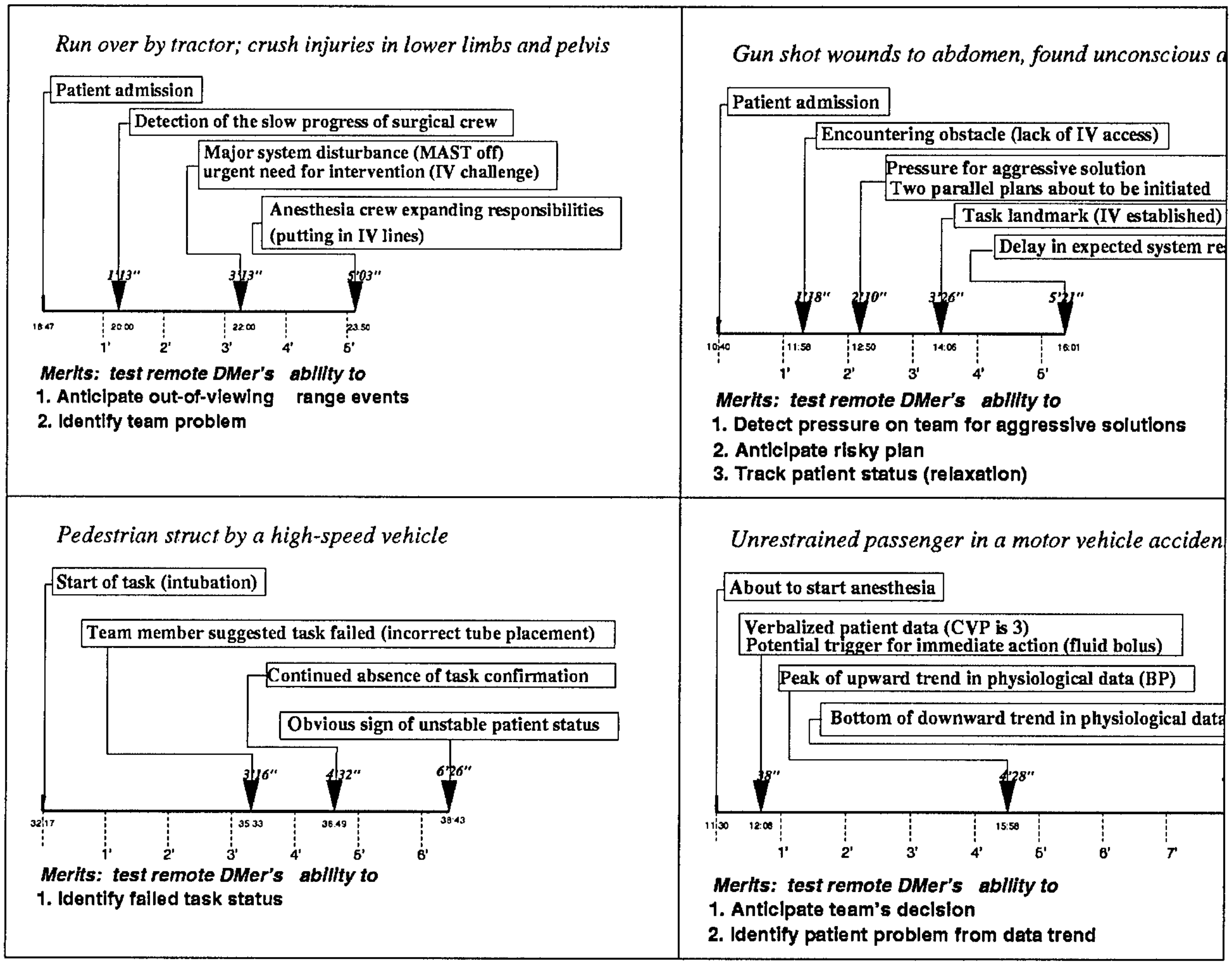

Table 1.2 *Overview* of the four cases selected in the experiments (top row: case 1 and case 2; bottom row: case 3 and case 4).

Case	Stop Points	Time	Scoring Items
Case 1	SP 1	1'13"	Detected the acute hemorrhage Anticipated "MAST[a] off" event Detected the slow progress of the surgeons
	SP 2	3'13"	Detected "MAST off" event Detected the urgent need for rapid infusion
	SP 3	5'03"	Detected ACP[b]'s effort in establishing IV accesses
Case 2	SP 1	1'18"	Detected the pressure on ACP to intubate Detected the lack of IV[c] access and obstacles to intubation
	SP 2	2'10"	Detected nasal intubation and IM[d] injection in the tongue Anticipated possible patient vomiting
	SP 3	3'26"	Recognized IV established
	SP 4	5'21"	Detected the delay in achieving patient muscle relaxation Put forward differential diagnoses for the delay
Case 3	SP 1	3'16"	Identified cues for missed intubation Identified cues for confirming correct ETT[e] position
	SP 2	4'32"	Detected the lack of positive ETT position confirmation Put forward differential diagnoses for the lack of positive ETT position confirmation
	SP 3	6'26"	Detected the need to remove ETT
Case 4	SP 1	0'38"	Detected the need for IV bolus
	SP 2	4'28"	Detected the increasing, very high BP[f] Detected the need for intervention
	SP 3	8'05"	Detected the decreasing, very low BP Detected the need for intervention

Table 1.3. Items used for scoring questionnaires at stop points (SP 1-4) for the four case segments (case 1-4). a: MAST = military anti-shock trousers; b: ACP = anesthesia care providers; c: IV = intravenous; d: IM = intramuscular; e: ETT = endo-tracheal tube; f: BP = blood pressure.

1.5 METHODS FOR EXPERIMENTS PERFORMED

Experiment 1

Three subjects went through a total of 12 experiment sessions (4 case segments each subject). An overview of these cases is shown in Table 1.2. There were four stop points when questionnaires were completed. Two subjects had one year and one 10 years of Shock Trauma experience. This experiment was designed to address what cues were detected and missed by experienced subjects.

Experiment 2

Four trauma nurses, four trauma anesthesiologists and four trauma surgeons participated in this experiment to assess the effect of experience background on remote diagnosis. This experiment followed up a hypothesis that was generated from experiment 1 as the reason why cues were missed.

The stop point questionnaire asked SME's to describe current patient status, current team activities, anticipated patient status and anticipated team objectives. Written or audio recorded responses were used and answers divided into: airway, breathing, circulation, patient status and injuries, team activities, other.

Experiment 3

Twelve subjects, four attending trauma anesthesiologists, three attending trauma surgeons, three experienced trauma nurses and two medically naïve graduate students (control) participated in this experiment. An eye tracker was worn by the subjects to evaluate video as a medium to convey information; to assess domain expert visual scanning patterns during remote diagnosis and to compare information gathering from the same scenarios viewed by anesthesiologists, surgeons and nurses. Two measures of visual scanning patterns were analyzed: fixation and dwell. A fixation was described as a cessation of eye movement; a dwell as a consecutive sequence of fixations within a given area of interest. The dwell time (start of first fixation to end of last) was taken as an indication of how focused the subjects were on a particular area of interest of the videotaped scenarios.

Experiment 4

In this experiment, we assessed team coordination and breakdowns to examine how a remote decision-maker could collaborate as an important member of the distributed trauma resuscitation team. The first part of the experiment examined how the trauma team coordinated and when coordination breakdowns occurred. The second part of the study examined uncertainty in resuscitation and team communication. This experiment was driven by the fundamental question of how it was possible for the trauma team to function so smoothly most of the time with so little apparent effort spent on coordination. Three types of critical incidents were

included in the stimulus material. These were decision points, high workload periods, and apparent problems in team coordination. The qualitative data were reported in two areas. First, task coordination or the distribution and delegation of tasks and information flow and second; the passage of information regarding patient status and contingency plans.

Experiment 5

This experiment was conducted to determine the impact of uncertainty on team performance. Using previous reviews of the stimulus material videotapes from those present during the real patient management and commentary provided by SME's not involved as participants in this experiment, we categorized uncertainties in the case segments as follows: mechanism and extent of injury, patients prior medical history, working status of patient monitors, the effect of treatment, availability of team members, task distribution among team members, intentions of team members, availability of resources (e.g., operating room, radiology), what occurred during transport and the status of the patient during field management.

1.6 FINDINGS OF EXPERIMENTS

Experiment 1 investigated what cues were detected and what was missed by remotely situated expert decision-makers.

The results showed that missed cues occurred for several reasons, including degradation of verbalizations and verbal communications because of background noise interference[21]; viewing range for the remotely situated subject was restricted with a fixed camera location; visual access from this fixed location was not secure because care providers moved in and out of the camera line of sight and sometimes obstructed the view at critical moments when the cue was presented; typical video imagery used, showed the activities of 3-5 crew members of the trauma team working on patient resuscitation and such multiple actions, appeared to overwhelm the remotely situated expert decision-makers causing visual information overload.

Some clues were not picked up by all remote decision makers. Difficulties in recognizing these cues included: lack of an adequate dynamic mental model of patient status because they had not participated in patient care and were therefore cognitively "out-of-the loop" in regard to their information seeking[22]; there was lack of context information in comparison to the on-site providers. It was not as obvious to the remotely situated person what other team members were doing or how to extrapolate their intentions; because not all concurrent activities could be simultaneously followed.

Experiment 2 addressed the question: What is the effect of the remote decision-makers experience background on the capability to extract information from these audio/video sources?

Nurses, surgeons and anesthesiologists understanding of the identical audio/video material was compared by responses to questions about the current patient status, team activities, future patient status and team objectives. The analysis of nurses,

surgeons and anesthesiologists responses compared performance of correct answers against an ideal understanding of the cases and content of the answers categorized into airway, breathing circulation, patient status and injuries, team activities and other.

The performance analysis showed that anesthesiologists performed better than the other two groups. Performance scoring items that presented difficulties included detection of conflicting plans, and anticipation of nursing plans. Surgeons and nurses did poorly in determining task status of placement of a breathing tube, traditionally the responsibility of the anesthesiologists.

Content analysis showed that the distribution of answers across the six categories (above) among all three groups of subjects was similar. The surgeons provided more general comments; the anesthesiologist subjects used a higher proportion of phrases describing airway related issues whereas the nurses were consistently more focused on teamwork.

All subjects experienced, at one time or another, similar difficulties to those in Experiment 1. An explanation for why anesthesiology subjects out performed the nurses and surgeons is that the videotapes selected for this experiment all contained the activities of airway management, a role performed by anesthesiologists on the trauma team. The traditional divisions of labor within the trauma team may have constrained the nurses and surgeons and prevented them from detecting critical cues. The nurses performed better than surgeons, this may have been motivational. The surgeons may have used different types of descriptions than nurses, but in general, surgeons provided fewer written and verbal responses than nurses or anesthesiologists.

These results suggest that experts with different experience backgrounds may appreciate different aspects of events and activities presented in audio/video sources.

Experiment 3 used an eye-tracking device to determine visual scanning patterns of domain expert observers.

Information extracted from video was identified by use of the eye tracker. Nurses, surgeons, anesthesiologists and medically naïve undergraduates (control group) participated. They provided verbal comments and answered questions about the current patient status and team activities and future patient status and team objectives, as in Experiment 2, while wearing the eye-tracking device.
All subjects spent the majority of the time looking at the head and faces of the care providers on the video. The eye movements of the control group were rapid over large areas of the video in comparison to the expert subjects. Subjects with different experience backgrounds among nurses, surgeons and anesthesiologists had different visual scanning patterns. The distribution of total time spent on the area surrounding the patients' head was just over 40% and on the care providers' under 40% of the total viewing time. The nurse subjects scanned more around the patient and the anesthesiologists looked most at the airway manager. Viewing of the vital signs data occupied about 10% of the total viewing time.

The eye tracking data corroborated the hypothesis of the effect of experience background on information extraction during remote diagnosis.

Experiment 4 was conducted to understand team coordination.

As a result of understanding team coordination, a remote decision-maker might be able to identify decision points, high workload periods and problems in team coordination[23].

Videotapes were reviewed and several non-communication task coordination activities were noted including: following the protocols, following the leader, anticipation of future events, activity monitoring the task status of team members. Explicit verbal communications regarding situational assessment and future plans were relatively rare in comparison to non-verbal communication. When team members voluntarily provided their views, it occurred when the team was clearly at a decision point. There was considerable variation among team leaders in plan verbalization with some leaders providing clear intentions; while others appeared to let the events drive the team actions and the goals were inferred by these actions.

Coordination breakdowns occurred in a number of crisis situations including when: extreme difficulties or unexpected patient responses were encountered which prevented the implementation of routine procedures; the team was under pressure to seek alternative solutions; there were unexpected attempts to adopt novel solutions to acute emergency situations. These breakdown situations compromised the abilities of the supporting team members to provide assistance because of their lack of anticipation of the need. Coordination breakdown occurred when the patient was so unstable that the treatment plan had to be abandoned, such changes in plan occurred during crisis and under great time pressure, and required the team to change their process from diagnostic activities (hypothesis seeking) to action activities (hypothesis testing) rapidly.

Verbal communication was viewed as only one of many ways teams use to coordinate their activities. Other communication media include; activities, workspace, events and focus of attention of team members. In most circumstances, team coordination was achieved with a minimum of explicit verbal communication.

Experiment 5. Analysis of Uncertainty in Resuscitation Events and Team Communications.

Forty videotaped cases were reviewed from our video library that identified a wide range of sources of uncertainty. A total of 76 uncertain items were identified by examining verbal communications and subject matter expert reviews. These uncertainties were categorized as patient related uncertainty (26%), including reports provided by distributed pre-hospital team members, effect of treatment interventions and mechanism of patient injury; and team/organization related uncertainty (41%), including task distribution among team members, interaction of other team members, status of team members task accomplishment, and resource availability and schedules. Many of these factors would also probably be causes of uncertainty for the military medicine team. It seemed that lack of communication among team

members and among personnel work in nursing, surgery, and anesthesiology contributes to many of the uncertainties identified. In addition, technological issues such as signal interference of patient vital sign monitors cause uncertainty in many crisis situations because of patient factors (low blood pressure, combativeness, etc.) cause signal detection failures[18]. Lastly, because of overlap in task distribution among team members, uncertainties occur about who should do what and when.

1.7 CONCLUSIONS AND RECOMMENDATIONS ON REAL-TIME DISTRIBUTED DECISION-MAKING IN EMERGENCIES

The cases on which this paper was based were selected to allow testing of the participating subjects as remote decision-makers. This meant that out-of-viewing range events were included to determine if these could be anticipated. Non-optimal case management situations were used as stimulus material to determine whether coordination failures could be identified. Risky interventions were included to see if the remote decision maker could anticipate the hazards of such plans when not co-located. Patient status after an intervention is part of what a care provider does to follow up the outcomes. The ability of the remote decision maker to seek follow up without direct participation in the intervention was sought in another of the cases, to determine whether they could track patient status dynamically over a period of time (about three minutes). Whether or not remote decision makers can detect some of the subtleties of local and peer pressures within a team was also assessed with cases where there was pressure to aggressively intervene, and situations where a team mate failed to identify the task status or the co-located team recognized positive or negative cues for task status. Whether a remote decision maker can prospectively anticipate the same decisions that the team ultimately made or whether they could identify patient problems from trends (patterns) of patient vital signs, was also tested with the cases used in this paper.

Understanding both verbal and non-verbal communications is an important part of real-time distributed decision-making. Capture of optimal verbal signs can be achieved both by tools such as standardized communication or call back protocols as well as technological solutions including individual microphones, directional microphones, and noise cancellation technology. Non-verbal communications cues can be captured by using multiple cameras to record the same event, including both close up and general environmental views. Multiple cameras also minimize restrictions in viewing range and access to non-verbal communications. The fixed camera provides a general overview of the entire area of activity and allows both identification of who is coming and going as well as provides some context for the team events. The shared event space, shown on such overview images, is an important media for non-verbal communication. The workplace designs should avoid interference with the function of the space.

In dynamic events with a multidisciplinary team, where simultaneous actions are part of the coordinated effort, it is easy to miss important interventions. Cues to prompt a remote observer may be useful to focus their attention on specific events or performance of particular parts of task performance when multi-tasking is occurring. A framework of prototypical sequences of tasks (e.g., ATLS protocols for resuscitation of trauma patients) can provide useful reference points to allow a

remote decision maker to understand what is occurring even though they may not have the same familiarity as the co-located team with their surroundings. Training of remote decision-makers in observation of events outside their usual domain of expertise can be helpful in ensuring maximal information input into their decision. Multiple domain expertise among multiple remote observers may be the only available means of ensuring real-time expertise for dynamic tasks. Training or cueing remote teleconsultants to systematically scan video sources may overcome the difficulties associated with rapidly evolving events.

The most straightforward, but most difficult to implement, strategy for keeping a remote decision maker informed and avoiding uncertainty is explicit verbalization of plans prospectively. Increased communication among the team, even defined communication protocols for certain tasks with call back by other team members confirming their understanding can be very useful. Improved reliability and artifact reduction among signals from monitoring technology would increase their decision-support usefulness, e.g., patient vital signs monitoring technology. Checklists of tasks to be completed in a sequence can help avoid omission and commission errors. They may be restrictive in dynamic and complex domains, as one of the characteristics of expert teams is that they can adapt their behavior to changing circumstances and so often do not follow predictable or prescribed pathways.

1.8 IMPLICATIONS

This paper has addressed the core of the onion by examination of issues directly related to optimal observational analysis of remote events through video, audio and data links using multiple sources of information from a single remote location. The paper examines team performance and does not propose any outcomes such as learning or success. Rather, it recommends a way that quantitative and qualitative data can be collected that might be used to confirm such outcomes.

Figure 2. *Video image of trauma patient resuscitation. This patient had a flail chest and major intra-abdominal bleeding. Vital signs show heart rate (HR) 91/min on extreme left. End-tidal CO_2= 19 mmHg, O_2 saturation = 86%, and non-invasive BP = 62/39 shown on the right side of overlay. Time code is shown beneath BP.*

Table 1.2 *Overview* of the four cases selected in the experiments (top row: case 1 and case 2; bottom row: case 3 and case 4).

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TELEHEALTH ADVANCES FOR DIABETES

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Introduction

Implementing a diabetes monitoring and management delivery system that reaches a large rural population and results in behavioral change is a significant challenge. Telehealth strategies including e-Health (i.e., via the Internet) may enhance access to the individual patient. Telehealth strategies may also assist the patient's family and support system in their home environment.

Specific Aims

This qualitative and quantitative clinical study sought to explore the relationship between e-Health interventions and the progression of renal disease in diabetics with Native Hawaiian ancestry.

Research Question

Are e-Health interventions significantly associated with the progression of renal disease in diabetics with Native Hawaiian ancestry compared to control patients who received regular physician care without e-Health augmentation?

Background and Significance

Rapid increases in the aging population — 34 million today in the USA and 70 million projected by the year 2030 (1) — signify a substantial increase in the demand for services from those with chronic illness. The proportion over age 65 is expected to increase from 12.4 percent in 2000 to 20 percent by 2030. In addition, minority populations will increase from 16.4 percent to 25.4 percent, with the largest increase (285%) occurring in Asians and Pacific Islanders (1).

e-Health

Telehealth tools as videophone, video teleconferencing, and Internet need to be explored to manage disease, promote health, and reduce health care costs for elderly persons with chronic disease. Studies document that elders with adequate support have an increased potential to remain in their homes.

One form of telehealth is using the Internet (e-Health) for the delivery of health care (2). Although there is extensive literature on telehealth and its applications, there is limited research documenting clinical outcomes associated with e-Health intervention (3). The data-based research related to telehome care, the most commonly used term for delivery of care in the home using telehealth technology, is summarized below in relationship to the major themes addressed: cost, satisfaction, access, and outcomes.

Cost

The literature indicates cost savings associated with the implementation of telehome care in both maternal child and elder populations (4). Cost comparisons of traditional care with telehome care provision for mothers with preterm labor documented significant cost savings ($14,459) per pregnancy (4). In another study, cost comparisons for outpatient services for patients with chronic disease did not vary significantly. However, the investigation took place over 1½ years; if equipment costs were amortized over a longer period of time, a greater cost savings for the telehome group would result. Hospital costs for the telehome group were less ($1,087 compared to $1,940)(5).

Satisfaction

Patient satisfaction and nurse satisfaction with telehome care were consistently high (6, 7, 8, 9). Although one investigation documented initial provider resistance, the intensity of the resistance improved over the duration of the investigation (5).

Access

Access to medical care can be defined as the ability of an individual to obtain health care services. In the early stages of telemedicine, consultations by a specialty physician were provided to rural communities, overcoming the barriers of distance, travel time, and costs (10). The same advantages can be realized with e-Health when patients have access to providers via the Internet without leaving their home.

From those initial telemedicine projects to the current use of e-Health in the home setting, patient access is enhanced when the health care provider has improved access to the data needed to evaluate patient progress and responds more quickly with treatment. Efficacy of telehealth to expand access to care has been demonstrated in a variety of patient populations: maternal-child (4), chronic disease (5), and the elderly (7). Enhanced access to diabetic disease management via telehealth with the goal of altering progress of renal disease has not been studied.

Outcomes

Many investigations did not specifically report outcome data. However, Morrison's study regarding management of preterm labor using telehome methodology clearly documented reduced numbers of infants admitted to the neonatal intensive care unit. It should be noted that significant differences were found between study groups in this trial for marital status and race. It is possible that these differences rather than methodology could have explained the differences in outcome. The analysis did not reveal any negative clinical outcomes.

Clearly a need exists to further evaluate the efficacy of e-Health interventions to reduce health disparities related to diabetes, especially in populations with health disparities such as Native Hawaiians, Asians, Filipinos and other Pacific Island people. Sample sizes for the few investigations that exist are relatively small. Many investigations are retrospective in design and measurements of clinical outcomes are inconsistent. At the time of this study there is no clear evidence base for e-Health practice related to care of any clinical population including diabetes. However the findings suggest that this methodology could improve health outcomes especially for those with chronic disease.

Diabetes

Comprehensive data are sparse on Type 2 diabetes mellitus for Pacific Islanders. Yet, the incidence of diabetes is considerably higher for those with Filipino and Pacific Islander ancestry (11). The prevalence rate for pure Hawaiians is nearly 50 per thousand, which is twice the rate of Caucasian residents of Hawai`i (12, 13). Further

data show that native Hawaiians die of diabetes at a rate of 117 per 100,000 — more than double compared to the average rate of 53 per 100,000 for other ethnic groups (14).

The cardiovascular and renal complications of diabetes significantly increase the incidence of chronic disease in Hawai`i (11). The Behavioral Risk Factor Surveillance System reports a rate of 52 per thousand of all adults in Hawai`i ever having been told they have diabetes, a number twice as high as the Healthy People 2000 goal (15).

Regarding Type 1 diabetes in children where the overall rate is 1.16 per 1000 (16), higher rates are displayed in some ethnic groups in Hawai`i than in others. The rate for Type 1 diabetes in part-Hawaiian children is 2.5 times as high as Caucasian children and 10-times higher than the rate for Japanese children in the same environment (17).

Despite these alarming discrepancies, emphasis on Type 1 diabetes is overshadowed by the rapidly increasing rates of Type 2 diabetes in Pacific Islander populations in Hawai`i. Indeed, the age-adjusted prevalence rates for Type 2 diabetes in Hawaiian Polynesians are among the highest reported for any Polynesian or part-Polynesian population in the world (16). Furthermore, mixed Hawaiian ancestry has not diminished the risk of Type 2 diabetes, unlike in other Native American populations. This discrepancy may be due to inaccurate ethnic self-reporting or because the mixed ancestry includes other ethnic groups with known high rates of Type 2 diabetes (16).

An increasingly Westernized and sedentary lifestyle is correlated with the increasing prevalence of diabetes in other populations and may be a factor in the high diabetes rates in native Hawaiian populations. A study comparing Japanese-American men who maintained either traditional Japanese or a modern American lifestyle demonstrated the influence of a Western lifestyle on diabetes risk. The more traditional

Japanese-American men had lower rates of diabetes than did the Japanese-American men who were more acculturated to a Western lifestyle (17). Other literature suggests that traditional cultural beliefs about the caretaking of ill family members and the concept of the spiritual unity of a person with the environment may prevent individuals from taking preventive measures and/or from seeking conventional medical care (18).

The Hawai`i Department of Health indicates 50 percent of the people with kidney failure in Hawai`i have diabetes, and the rate of newly diagnosed end-stage renal disease (ESRD) in 1994 was more than three times higher in Hawai`i than the national average (19). According to the Center for Disease Control, the direct (medical care) and indirect (lost productivity) costs of diabetes in Hawai`i was $613,000,000 in 1993 (20, 21).

Individuals with diabetes mellitus are at high risk for many complications that are gradual, insidious, and may be irreversible. An example is diabetic end-stage renal disease (ESRD). Once symptoms of ESRD present, the individual has kidney failure. It is only a matter of time until hemodialysis is required to sustain life. The need for dialysis has a profound impact on cost of health care and the individual's quality of life.

Diabetic patients and their families must understand that diabetes is a chronic illness and there is no cure: only adherence to diet, exercise, and medication can modulate the impact of diabetes. Through stringent self-monitoring blood glucose (SMBG), blood pressure (BP), and adherence to diet, exercise, and medications, diabetic ESRD and other complications can be minimized (22). A 10-year study conducted by the American Diabetes Association on Type 1 diabetics entitled Diabetes Comprehensive Control Trial (DCCT) found that diabetes mellitus complications could be stabilized or reversed with tight daily glycemic control within normal range (23). These

recommendations were incorporated into the Hawai`i State Practice Recommendations for Diabetes Mellitus. The Advanced Practice Nursing protocols developed for this investigation are based on these recommendations.

Locus of Control

Health behavior is thought to be a function of belief about the degree of control individuals believe they have over life events. Wallston, et. al. suggest that health locus of control is useful for predicting some health behaviors but not others (24). Pima Indians with internal locus of control were more physically active than those with an external locus of control (25). The Wallston locus of control scale proposed three components of control: internal, powerful others, and chance. Given the potential for understanding an individual's decision about disease management, these three measures of locus of control were included in the data collected.

Research Design and Methodology

This qualitative and quantitative clinical trial monitored the progression of renal disease in two groups of diabetics with Native Hawaiian ancestry. The experimental group received e-Health teleconferencing visits two times per week, in addition to usual care by their physician. The control group received usual care by their private physician. No attempt was made to control "usual care". "Usual care" included routine screening and diabetic education by physicians. Differences in frequency of patient follow up with physicians were not evaluated.

Sample

Study participants were of Native Hawaiian ethnicity, 18 years of age or older, with a medical diagnosis of diabetes mellitus.

Letters were sent to private physicians and community groups inviting referrals into the project. These physicians and groups were provided screening questionnaires and consent forms. Potential participants were identified. At the time of initial consent, participants were told they would be assigned to either the experimental or control group. Patients were assigned to groups by pulling numbers out of a hat.

Participants were contacted via phone or mail with additional program information, entry questionnaires, and an invitation to the orientation class. During the orientation class participants provided informed consent and received instruction on use of the computers, software, and peripheral devices (glucometers and blood pressure cuffs). Appointments were made for installation of the computers in participant homes. Study computers were password protected and all patient data were maintained by a numerical coding system.

Procedures

Written evidenced-based advanced practice nursing protocols were developed including monitoring, education, counseling, support, and referral components. The focus of the interventions was on lifestyle modification resulting in healthy adaptation reflected by decreased progression of diabetic disease.

Three advanced practice registered nurses (APRNs) participated in development of the protocols based on published evidence to assure face validity.

Reliability was assured because only these three APRNs provided care using e-Health methods. Validity was affirmed by having the protocols reviewed by a nephrologist. The protocols are available from the Principle Investigator. The clinical trial procedures and consent forms were evaluated and approved by the University of Hawai`i Office of Research Services, Committee on Human Subjects.

The experimental group received e-Health teleconference visits 1-2 times per week by the APRN, in addition to usual care by their physician. The e-Health visits included a diabetic education protocol that focused on patient and family education, support, medication management, and monitoring of health measures.

An Internet website was created for the project. The site included pictures of project staff, diabetes information, instructions on use of glucometer, icons for obtaining diabetic information on the Internet, and use of email.

Equipment and Technical Support

The e-Health visits were conducted using home computer technology (NEC 466 Cache Pentium PC computers with 64 MB memory purchased at a local retail store) and modem connection to the Internet. Inexpensive Intel Cameras and free NET Meeting software allowed videoconferencing. The technology support team consisted of Community College students enrolled in the computer technology program. The students provided technical support to both practitioners and patients, and made telephone, videoconferencing, and home visits.

Monitoring

Blood pressure, weight, and blood sugar were reported by the patient and evaluated by the nurse at each e-Health visit. Downloadable Lifescan glucometers were used to measure blood glucose. Weight and blood pressure were self-reported following the orientation program and demonstration of reliability.

<u>Instrumentation</u>

Physiologic, experiential, and behavioral variables were measured pre and post treatment to assess the dependent variable of progression of renal disease. Urine microalbumin (reported as ratio of microalbinuria/urine creatinine-specific) evaluated the progression of renal disease. Standard laboratory analyses were used to measure urine microalbumin. Microalbumin is a valid objective measure of progression of renal disease and indicates the degree of blood sugar control for the diabetic patient over a period of time.

Experiential data included qualitative assessment (questionnaire) of computer competence, satisfaction, ability to use diabetic Internet resources, and locus of control measured using a 15-item Health Locus of Control Scale (Wallston, 1981). Demographic data, lifestyle information (questionnaire), and beliefs toward health care (questionnaire) were collected at the onset and at the conclusion of the study.

The locus of control questionnaire was administered to patients in the experimental group at the onset of treatment (Pre) and re-administrated at its conclusion (Post). Pre and Post scores were tallied for the 16 resulting patients on each of the three locus of control beliefs: Internal (the extent to which one believes that internal factors are responsible for health or illness); Chance (the belief that health or illness is a matter of fate, luck, or chance); Power (the belief that one's health is determined by powerful

others such as a health professional). Each measure was based on a 5-point scale, where "5" indicated the highest level of that factor.

A 4-item Satisfaction questionnaire was administered to experimental patients at the conclusion of treatment to assess participant affect on the e-Health approach.

Results

Demographic

The initial control group included 34 individuals with roughly equal males to females (53% male). At the conclusion of the study, researchers were able to locate and obtain data for 11 of the control subjects, for a retention rate of 32 percent.

The experimental group included 30 individuals with comparable gender distribution (50% male). Twenty-one of the experimental patients participated in the project for the entire year, for a 70 percent retention rate. Sixteen (16) completed the locus of control post test. Seventy-five percent of the experimental subjects did not have a computer or Internet access prior to the study.

Microalbinuria/Creatinine Ratio

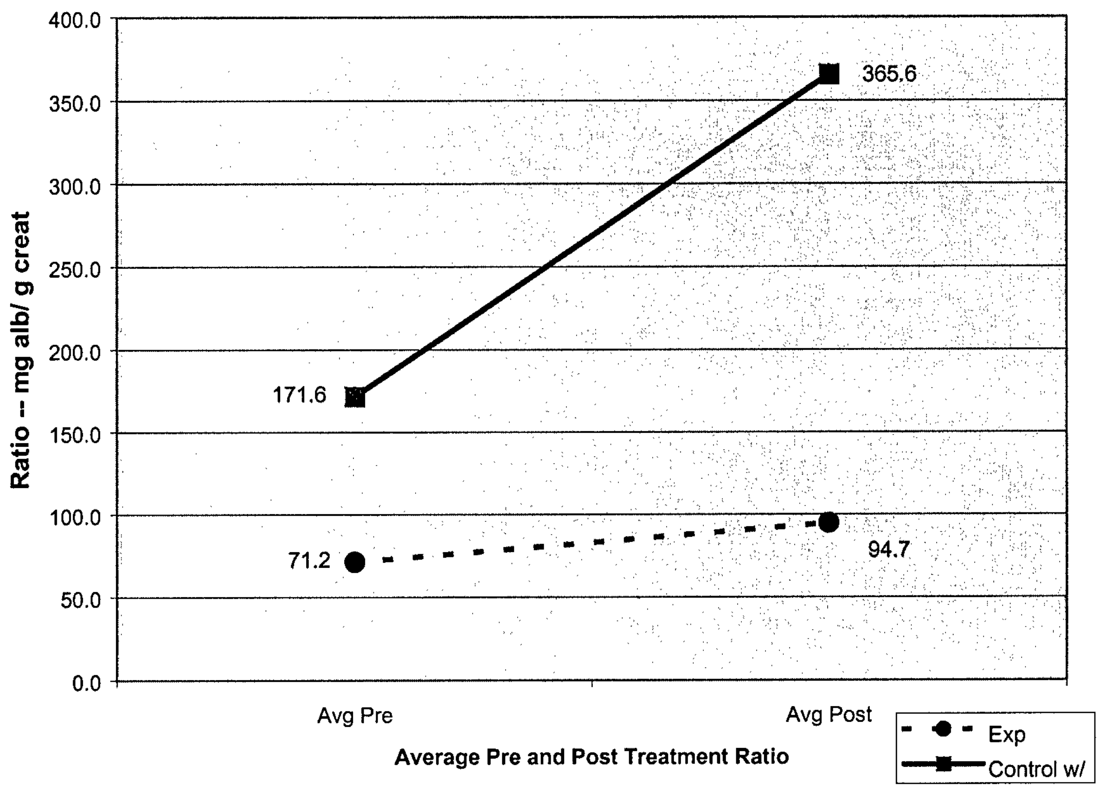
Pre and Post scores for microalbumin (mg/L), creatinine (mg/dL), microalbumin/creatinine ratio (mg/alb), and percent change in ratio were evaluated for the experimental and control groups. A negative value in the percent change indicated the customary progression of renal disease, whereas little change reflects stabilization of the disease and a positive value signified reversal of the disease and improved health.

Progression of renal disease as measured by an increase in the microalbumin/creatinine ratio was observed in a greater proportion of the control patients (n=7, 63.6%) compared to the experimental group (n=11, 52.4%). Additionally, the average increase in ratio was considerable higher in the control group (1,315%) compared to that of the experimental group (90%).

Some patients in both groups demonstrated improvement, but the experimental group had a greater proportion showing improvement (n=10, 47.6%) compared to the control (n=7, 36.4%). The average decrease in microalbumin/creatinine ratio was 54.2 percent in the experimental group and 53.2 percent in the control group. However, the experimental effect is spuriously dampened by post urine microalbumin scores of four experimental patients that were so low (<3 mg/L) that the ratio could not be calculated. Such decrease in microalbumin may signify a lack of progression of renal disease. This is a goal of tight control of blood sugar in the diabetic patient.

To test the significance of the difference between experimental and control group means, a Chi Square analysis was performed on the average onset and post ratios. As seen from Fig. 1, the average onset ratios for the experimental and control groups were, respectively, 71.2 and 171.6. (A t-test showed these pre-test means did not differ significantly, $p \leq .34$). At the conclusion of the treatment period, the average post ratios were higher for both groups, at 94.7 and 365.6 respectively. However, the control group average was 247.3 points higher, compared to only +23.5 points for the experimental group.

Fig. 1: Pre and Post Ratios for e-Health (Experimental) and Traditional (Control) Treatments



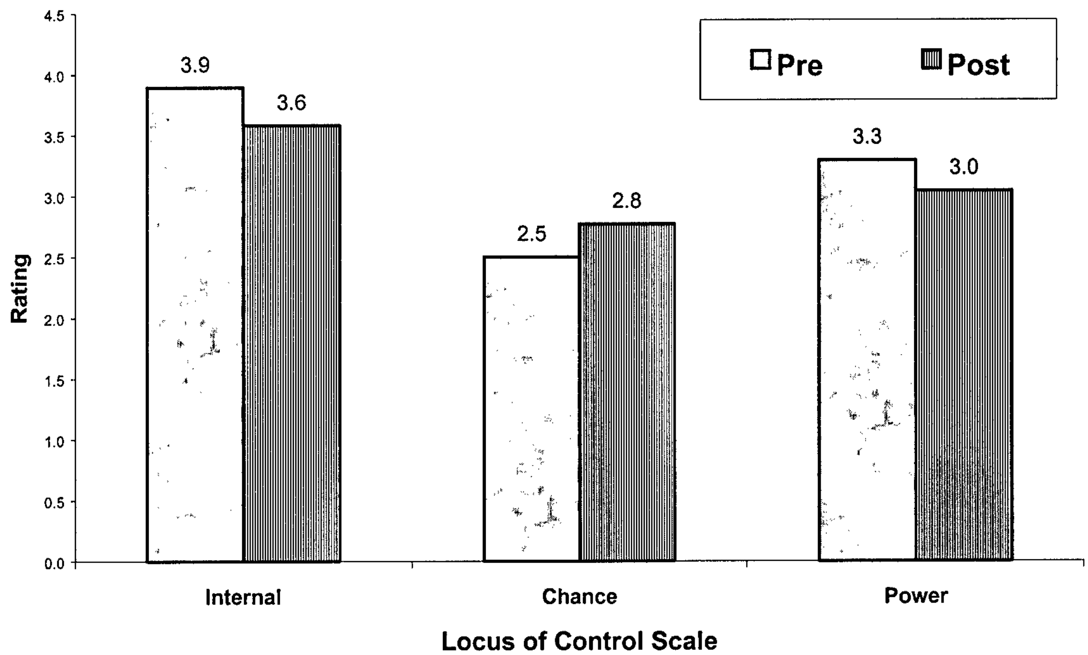
The Chi Square Test for Independence supports rejection of the null hypothesis that the average ratio is independent of treatment (X^2=2.7, df=1, 2-tail test, p $\leq$ .01). The post ratio score appears to depend on the treatment. The rapid ascent of the Post mean found under the control group suggests that the standard treatment will result in progression of renal disease, which may be significantly slowed by intervention of e-Health visits.

Locus of Control

The most consistent change in locus of control was seen on the Internal scale, where Post scores decreased for 11 of the 16 patients (68.8%) who completed both Pre and Post surveys.

As seen from Figure 2, the average Pre score at 3.9 was on the high end of the 5-point scale, and the average Post score was lower at 3.6 points. A t-test conducted to determine the significance of the difference between the two means approached the acceptable level of ≤ 0.05, but reached only $p \leq 0.08$ on a 2-tailed test.

Fig.2: Locus of Control Pre and Post Comparisons



On the Chance scale, the mean Pre score (2.5) was at the midpoint of the scale. The Post mean of 2.8 was higher. The t-test, however, did not find this difference to be significant ($p \leq 0.22$). Individual variance was rather high on this measure, with Post scores going up or down about equally among the 16 patients (down = 7, 43.8%; same = 1; 6.3%, up = 8, 50.0%.)

Little change was also found on the Power scale. Here the mean score went down from 3.3 to 3.0. An equal number of patient Post scores went down as up. The t-test did not find a significant difference between the means ($p \leq 0.20$).

Satisfaction

Satisfaction with the e-Health protocol was assessed from responses of 15 patients to a 4-item questionnaire that evaluated access, technical support, comfort with e-Health, and overall satisfaction.

Table 3 shows patients were quite favorable toward the e-Health treatment. Practically all responses were high ranks of 4 or 5 on all four dimensions of satisfaction.

Table 3
Satisfaction Questionnaire Responses

Item	Disagree		Agree		
	1	2	3	4	5
I was able to contact my nurse when I needed to.				30%	70%
I was able to obtain technical support when I needed it.			7%	7%	86%
I felt comfortable visiting by televideo.				15%	85%
Overall, how satisfied were you with your e-Health visits?		6%	6%	13%	73%

Further analysis was conducted using the Overall satisfaction item to ascertain whether a relationship exists with a patient's locus of control. If it were determined that a questionnaire could adequately predict which patients would be least satisfied with telehealth treatment, then a survey be could be used before treatment to select which patients who would have the greatest likelihood of benefiting. On the Overall Satisfaction item, the mean rating was 4.5 from the 15 patients who responded. High ranks of 5 or 4 were awarded by practically all (87%) participants (11 = 5-rank; 2 = 4-rank). Only the two remaining participants assigned a rank of 3 and 2, respectively. This lack of variability in ratings precluded administration of a test of significance on the correlation between

measures of Satisfaction and Locus of Control. As an aside, however, it is interesting to note that both participants who expressed the lower levels of satisfaction had relatively high scores (4.6 and 4.2) on the Internal scale.

Access

The e-Health intervention provided access to health information and guidance for subjects, their families, and their friends. A positive outcome of the study was the participation in e-Health visits by members of the subject's "ohana" (family group). This access provided the practitioner with important instructional opportunities with the Ohana.

All experimental patients reported that the nurse involved them in their plan of care, and 93 percent shared information gained during the project with family and friends. When asked, “Did you feel that this care delivery system invaded your privacy?” all experimental patients answered with no. A large percentage (93%) indicated they would recommend this program to other diabetics, and two-thirds (66%) indicated they wanted to continue in the program in the future.

Technical Support

Technical support was important to the success of the program. Most patients utilized technical support for questions and assistance. Most (86%) indicated they were able to obtain the technical support they needed and 93 percent indicated their questions were answered adequately. Most subjects indicated they utilized technical support six or more times over the one-year period. The majority of the technical support requests were during the first three months of the study.

It is important to note that even though technical support was essential, the services were provided utilizing cost-effective college students and sometimes, in the home, the children or grandchildren of the patients.

Conclusions

This study demonstrates a successful utilization of e-health to impact health care outcomes. The use and acceptance of the e-health visits by both nurse practitioners and patients with little computer experience illustrates the potential for peeling the layers of the onion to dramatically change health care delivery. Early in the study, alliances developed between the project technician and the most computer savvy individual in each home. The impact of these alliances on stability of the e-health intervention is demonstrated by the 70% retention rate for patients in the experimental group.

Effectiveness. Diabetic subjects of Native Hawaiian ancestry who received usual physician care experienced significantly greater progression of renal disease (measured by ratio of microalbinuria/creatinine) indicating poorer control of blood sugar over the study period, compared to experimental subjects who received regular care augmented e-Health educational protocols.

Locus of Control. The locus of control analysis found the relatively high Internal scores at the onset dropping after treatment. This drop approached significance ($p \leq 0.08$) with the sample size of just 16 subjects. Further research conducted on a larger sample might find support for a hypothesis that e-Health monitoring attenuates high levels of Internal control. Would it be plausible that attenuated Internal control

indicates patients became more accepting of the challenges of their diabetes and the importance of disease management?

Satisfaction. TeleHealth in the form of e-Health videoconferencing visits was well accepted by patients, who had little prior computer experience.

Increased Access and Decreased Costs. Among the more interesting findings of this study was confirmation that patients could receive effective medical/health interventions without leaving their home. The e-Health methodology proposes a number of features that promulgate a conclusion that the future of medicine will incorporate telehealth practices as a way of improving patient access.

- Cost of equipment is not a barrier. The e-Health methodology used a standard computer with Internet access found in many homes today. The software is downloadable free from the Internet with new features to manage privacy issues.
- Less mobile elders and those with conditions making it difficult to get around can switch on a computer to access medical monitoring, in lieu of physically getting to a provider's office.
- Rural patients need not travel long distances, and instead gain access to medical monitoring on the computer just an arm's reach away.
- Seniors and others who no longer drive can circumvent problems of securing rides to the doctor's office.
- Inclement weather, blocked traffic, and treacherous roads are not barriers to receiving medical attention.
- Travel time and mileage expense are eliminated for both patients and providers, who no longer need to travel to reach each other's office or home.

Future Research. While the results did affirm the association of nursing telehealth intervention with improved patient outcomes, the sample size was small and the comparability of groups was not assured. The effectiveness of nursing telehealth strategies in supporting patient management of chronic diseases must be further validated using randomized controlled clinical trials with larger further samples. The aging population and the inadequate supply of health care providers demands the use of cost-effective strategies to manage diabetes and other chronic diseases. Telehealth strategies devised by advanced practice nurses may address this need.

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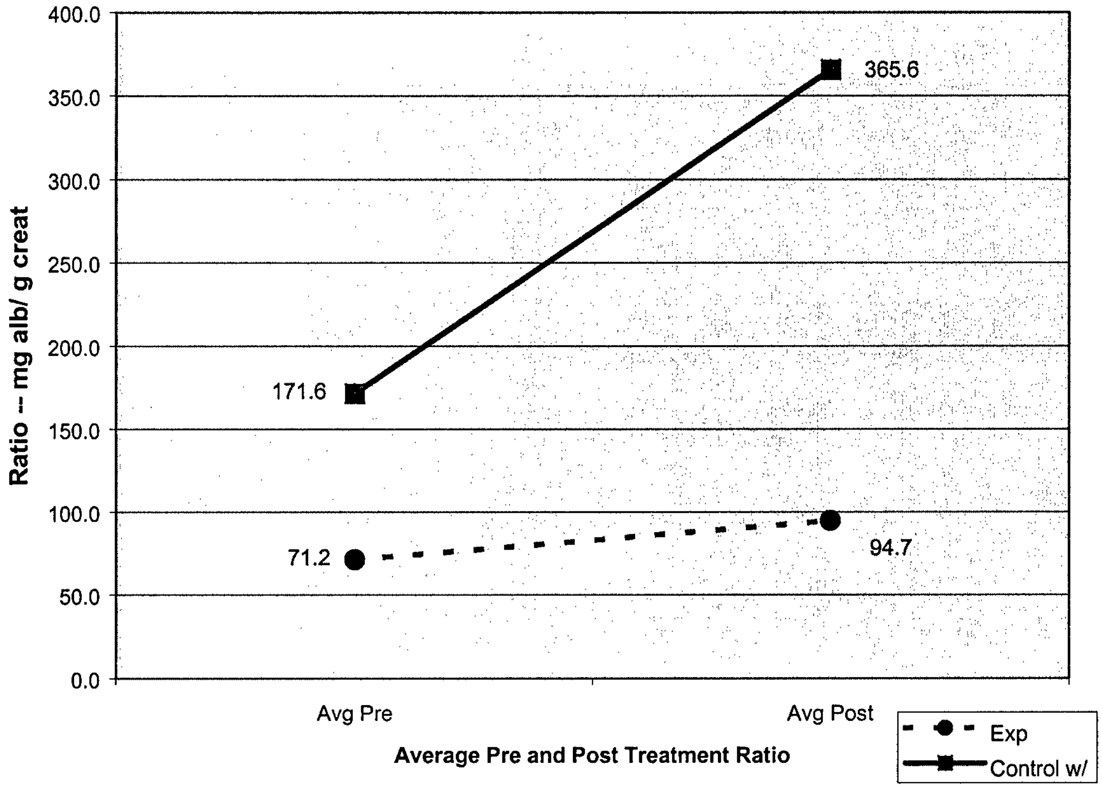
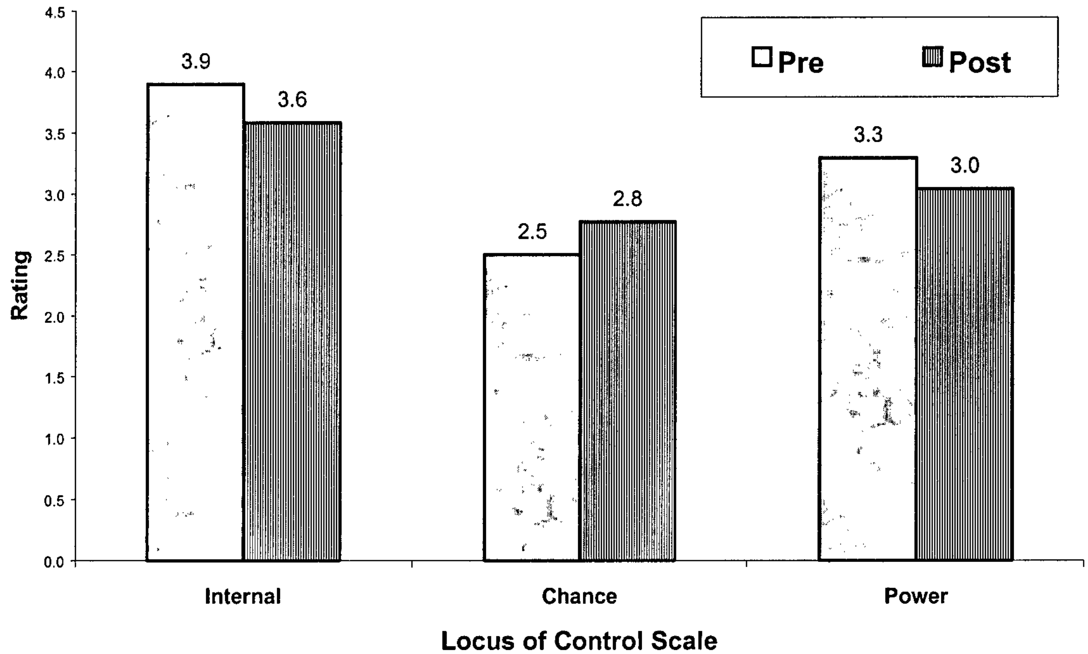


Fig.2: Locus of Control Pre and Post Comparisons



Evaluating the Human Dimension of Primary Care Telemedicine Encounters

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The initial debate about telemedicine was primarily centered on connectivity issues – for the most part, technology is no longer the major concern. When other questions such as cost effectiveness of telemedicine have entered the discussion, the reviews seem to be mixed. In a systematic review of studies on cost effectiveness, few have conclusively demonstrated any cost benefit data.[1] Yet, when human factors are considered such as lost productivity resulting from employees who miss work to obtain outpatient medical care or to return for a routine follow-up visit with their primary care provider, telemedicine at a large worksite has been shown to provide a significant cost savings and increased productivity.[2] Another branch of research has centered on the critical factor of physician acceptance of telemedicine. Using the Technology Acceptance Model (TAM) developed by Davis[3] to assess *intention to use*, Hu, et al., found that a positive perception of the technology's usefulness for physicians was crucial, while *ease of use* was reported to be not as important.[4]

There is no doubt that discussions on connectivity and cost issues will continue. However, we believe the paramount focus in telemedicine is shifting to a consideration of the patient-provider relationship, and becoming centered on communication issues. In

looking at primary care telemedicine, we believe that issues of communication are one example of themes that cross the dimensional characteristics (individual, technology and organizational context) of the TAM model. Because traditional healthcare is most often a face-to-face interactive process between provider and patient in a closed-door examination room, a major issue centers on how distance and technology affect the patient-provider relationship during a telemedicine visit.

While our research does not attempt to investigate the full TAM application, we do seek to understand patient and healthcare provider perceptions of telemedicine, as well as to determine potential techniques and strategies for enhancing communication in primary care telemedicine encounters. Consequently, we believe that primary care telemedicine provides us with an authentic setting for considering the various aspects of communication that make up the patient – provider transaction in an electronically mediated clinical encounter.

In this chapter, we discuss an inclusive and positive approach for investigating patient-provider relations and perceptions of communication quality – the *human dimension* in primary care telemedicine by: a) targeting central communication issues; b) developing a working description of *transactional presence* as an approach for supporting effective patient-provider relationships; c) describing a Telemedicine Communication Matrix which visually represents components associated with technologically mediated communication events; and d) reporting on five research projects that we conducted on aspects of the human dimension of primary care telemedicine.

The Primary Care Setting

Primary care is considered to consist of three generalist medical disciplines: Family Medicine, General Internal Medicine, and General Pediatrics. The American Association of Family Medicine provides the following definition of 'primary care' on their Web site:

> Primary care is that care provided by physicians specifically trained for and skilled in comprehensive first contact and continuing care for persons with any undiagnosed sign, symptom, or health concern (the 'undifferentiated' patient) not limited by problem origin (biological, behavioral, or social), organ system, or diagnosis.[5]

In a face-to-face encounter between a healthcare provider and patient in a generalist physician's office, the opportunity for promoting effective communication and for developing a healthcare partnership usually begins with the 'visit', which typically includes a complete health history (or *focused* health history on returning patients) and physical exam. Taking a patient's health history contributes to a process of developing interpersonal *social presence*, i.e., interpersonal awareness, interaction, and relational appreciation. At the same time, taking a patient's health history is often viewed as a form of transactional communication, i.e., an interaction or conversation with a purpose – to gather information form the patient, to establish a trusting and supportive relationship, as well as to offer health information and counseling to the patient.

Not only is good communication essential in a face-to-face encounter between patient and provider, but effective communication is integral to optimal healthcare. For example, poor communication can impact the ability of physicians and patients to form true decision-making partnerships through: a) patients' inability to elucidate their health history and physicians' inability to solicit accurate information; b) physicians' inability to

adequately explain a diagnosis, prognosis, and quality of life choices; and c) patients' lack of recognition of the need and value of healthcare choices and understanding of test results. Yet the patient-provider relationship is considered central in patient care,[6] and United States biomedical ethics are based on a model that emphasizes patient autonomy and self-determination emphasizing informed consent.[7]

Interestingly, a 2003 advertising campaign for a midwestern healthcare clinic captured current social concerns related to the fundamental role of communication in the patient-physician relationship. The advertisement begins as follows: "I want Doctors who listen. Doctors who discuss. Doctors who care".[8] The text succinctly captures several important communication concerns and needs of patients seeking high quality interactions with healthcare providers.

While the face-to-face encounter between a healthcare provider and patient may be considered the ideal for promoting effective communication, it does not necessarily guarantee successful communication or the feeling of social and psychological *presence*. Moreover in a telemedicine encounter, psychological and technical 'filters' impose upon and challenge the development of perceived *presence*. We believe that two-way communication between a patient and his or her healthcare provider in which both feel *present* with each other during a face-to-face (or telemedicine) clinical encounter are more likely to develop into a successful primary care partnership.

Communication Issues in Primary Care Telemedicine

Technologies, such as telemedicine systems, have the mediating capacity to bring people together in real time even though they are physically separated by distance. Yet, because communication and the presence-distance dichotomy is mediated by technology, there are

additional factors and filters that can impact a healthcare provider's ability to attend actively and dialogue with the patient, to empathize, to diagnose accurately, and to establish and sustain a primary care partnership. For example, if video images and sound quality are poor, then providers may not be able to detect and diagnose health problems associated with physical appearance, such as abnormal skin coloration or they may not be able to pick up on patients' health concerns conveyed through vocal expression. Concurrently, these same factors and filters can affect patients' perception of connection, satisfaction, confidence, and efficacy, as well as influence their ability to interact effectively and build a successful primary care partnership with their primary care physician.

In developing our research into *transactional presence*, we considered the communication theory of Jurgen Habermas.[9,10] One of the basic distinctions in his work is between: a) strategic forms of communication where the purpose is using language in order to have certain effects; and b) communication oriented toward understanding. What the communication processes in both of these basic distinctions have in common is that they can be considered to be directional – both aspects of the dichotomy have the intent of moving the listener in a particular direction.

Habermas's framework for communication, when applied to a primary care telemedicine encounter, provides us with some potential insights into understanding the dynamics of the patient-provider dialogue in terms of developing *transactional presence*. Here we consider the patient-provider relationship in terms of a bond or trust that needs to be established within a communicative relationship. While the Habermasian view centers on an open-ended communicative process to achieve understanding and an

equality of respect, 'participants' also have a responsibility to similarly give and receive (qualitatively) within the context of the telemedicine encounter. Patients have the responsibility to 'move' the dialogue along toward an answer to their medical questions so that they develop an understanding of the issues; physicians have the responsibility to 'move' the discourse toward a resolution of the presenting problem.

Research Issues

The issues of technologically mediated communication and the communication presence-distance dichotomy, raise a set of research questions for investigating patient and provider perceptions of primary care telemedicine encounters. These include, but are not limited to the following:

- How might a consideration of human, technological, and environmental dimensions inform an understanding of communication presence and lead to a working definition of *transactional presence*?
- What are the central human, environmental, and technological communication factors and filters associated with patient and provider perceptions of presence and/or distance in primary care telemedicine?
- How might the perceptions of patients and providers about communication *transactional presence* influence their evaluation of primary care telemedicine?
- How might the cultivation of *transactional presence* and the monitoring of *transactional distance* increase patient and provider perceptions of satisfaction, efficacy, and partnership in primary care telemedicine?

Transactional Distance

Within the context of distant education, Moore centered on developing a concept of *transactional distance* – the perceived distance in student-teacher learning relationships, as well as the influence of communication mediated by technology.[11,12,13] Moore's concept holds possibilities for application to studies connected to perceptions of physical and psychological distance in telemedicine encounters, and extends to a consideration of how these perceptions might influence communication in patient-provider relationships. More importantly, *transactional distance* implies a reciprocal, and perhaps more positive concept for considering communication and perceived relationships in telemedicine visits, i.e. *transactional presence.*

Based on the work of Moore, Bischoff, et al. constructed an operational definition of *transactional distance* as "...the perceived interpersonal closeness between the teacher and student, among students, and between students and the teacher, as perceived by the student respondents".[14 p..5] Two elements associated with transactional distance, *dialogue* and *structure*, have been important discussion points concerning student-teacher transactions in traditional classrooms.[15] These concepts have been associated with inquiries into connecting teacher-student transactions to learning outcomes,[16] and have developed into significant themes in distance education since the early 1970s.

For example, when faculty deliver content through a one-way lecture format, interpersonal distance between teacher and student is generally increased by linear structure, limited dialogue, and spatial distance. In contrast, small group discussions and problem-based learning (PBL) environments typically represent close or small transactional distance by decreasing the linear structure of the student-teacher interaction, increasing human dialogue, and decreasing perceived interpersonal spatial distance.

From Classroom to Clinic

Translating the concept of *transactional distance* from the discussion of the classroom to a telemedicine encounter, allows for some parallel observations: First, the smallest transactional distance possible is desirable; and second, the structure of the telemedicine encounter is critical. Additionally, transferring the points made concerning transactional distance to primary care telemedicine raises potential implications for developing and sustaining good patient-provider relationship.

Despite technological advances, history-taking and the physical examination remain a major component of a clinician's diagnostic ability. Previous studies estimated that 50% - 70% of diagnoses were dependent on the quality of data collection and integration,[17] and that faulty data collection or integration accounted for many diagnostic errors.[18,19] It may be the solid presence of the patient and provider dialogue that will be the lynchpin for determining effective telemedicine. If there is a breakdown in patient-provider communication, if technology 'filters' the provider's questions or the patient's responses, or if patients only pretend to understand the primary diagnosis and plan of care, errors will occur and optimal healthcare will not be provided resulting in poorer clinical outcomes and avoidable problems.[20]

For optimal healthcare to occur, technical, environmental, and human factors that serve as positive communication channels, conduits, or supports for good dialogic interaction, need to be identified, developed, and sustained. In a similar manner, technical, environmental, and human factors that serve as communication constraints or filters with negative impact, need to be eliminated or at least reduced. For example, a videoconference system that consistently channels 'true' (as close to physical reality as

possible) visual images and sound contribute to a physical impression of presence necessary for interpersonal interaction. Depending on nonverbal cultural codes, human factors such as frequent patient and provider eye contact may add to personal interpretations of physical and psychological presence.

In other words, facilitating close, mediated feelings and perceptions of interpersonal presence in a primary care telemedicine encounter means that we must account for and yet move beyond the physical dimensions represented by distance and technology. Supporting effective primary care telemedicine interactions rely upon, we believe, creating guidelines for developing a personal *presence* in a telecommunicated event.

From *Transactional Distance* to *Transactional Presence*

Moving the initial debate about telemedicine from connectivity issues to human factors focusing on communication is a commonsense evolution. We have developed rather objective assessments measures, which can be used by technicians for a wide variety of variables from sound to picture quality. We have asked patients and providers about the quality of the picture transmission and audio levels, and looked to professional TV newscasters for tips on dressing for 'prime time'. However, it is the interpersonal relationship developed between a provider and his/her patient, traditionally in a face-to-face closed-door encounter, that is the evolving focus in primary care telemedicine.

Garrison and others began to expand upon the utility of constructs other than connectivity issues in electronically mediated spaces when they characterized four phases of cognitive presence: evocative, inquisitive, tentative, and committed.[21] Their model focused on higher-order thinking skills, and depicted interaction in an online learning

environment as coordinated and synergistic, not undirected, unreflective, or as random exchanges of opinions. The primary care telemedicine encounter exhibits a variation of the four cognitive phases of presence as well as patient and provider interactions that appear at times synergistic. Likewise, Social Dynamic Theory informs us that social spaces are those places in which individuals interact-transact, influencing one another to take certain actions.[22] Originally conceptualized as interactions occurring within a defined physical space, the theory has expanded to include the mediated space provided by video-conferencing. While not physical in the purest sense of the term, videoconference space offers a different meeting place for patient and provider to interact and transact. This 'different' space-place suggests a growing concern for immediacy "the degree of perceived physical or psychological closeness between people".[23 p..212] In our discussion, we continue this dialogue to explore a potential 'umbrella' for discussions of human factors – the construct of *transactional presence.*

Presence (being engaged with another) may simply be described as 'being with'. How do patients and healthcare providers achieve 'being with' one another in a traditional clinic encounter? Being physically, emotionally, and cognitively 'present' and engaged in a face-to-face clinical encounter is a goal of primary healthcare providers – achieving that same level of interactivity in a primary care telemedicine encounter requires an even higher level of engagement, or attention to those mediating factors and filters imposed by technology.

Lombard and Ditton synthesized the literature on non-mediated presence from such fields as communication and psychology to inform their understanding and representation of technology mediated presence. They found six conceptualizations

linked to presence; five of the six are especially pertinent for considering the development of presence in primary care telemedicine: 1) Social richness – the feeling of authentic togetherness, which supports patient-provider relationship construction; 2) Realism – the perception of physical accuracy, which not only assists diagnosis, but human bonding; 3) Transportation – the feeling of being there, here, or together, contributing to patient-provider perceptions of immediacy and the quality of their social interaction; 4) Immersion – the feeling of full involvement, which leads to successful healthcare transactions; 5) Medium as social actor – the perception of and response to cues given by the medium, such as healthcare providers use of a close-up image (of themselves) to prompt in the patient a response feeling of provider concern.[24]

Social presence has been defined as the degree of awareness of another person in an interaction and the consequent appreciation of an interpersonal relationship, and includes factors such as facial expression, direction of gaze, posture, dress, nonverbal cues, and vocal cues.[25] Social presence in an online learning environment was defined as a measure of the feeling of community (being a part of, being together) that a learner experiences and is represented by three dimensions: 1) Social context – task orientation, privacy, topics, recipients / social relationships, and social process; 2) Online communication – attributes, application, and perception of the language used; and 3) Interactivity – those cooperative activities and communication styles used by online learners.[26] When social presence, through diverse forms of dialogic interaction is encouraged and supported, then a close social transactional distance can be imbedded and developed in 'distance' learning relationships.[27]

In a similar manner, social presence in a telemedicine primary healthcare encounter can be described as a measure of patients' and providers' feelings of being together in a social-professional context that is defined by or constructed through mediated interactivity.

An important dimension of that interactivity is the seamless integration of a provider's interpersonal communication and interviewing skills. Brammer and MacDonald constructed a set of seven skill clusters to guide and develop effective communication in professional 'helping relationships' such as primary care events. The skill clusters are: 1) listening, 2) leading, 3) reflecting, 4) challenging, 5) interpreting, 6) informing, and 7) summarizing.[28] These present an important framework for providers to consider as they cultivate presence within the communication domain of primary healthcare, whether that care is given in a traditional face-to-face or in a telemedicine encounter.

Even with this discussion as background, the telemedicine primary healthcare encounter requires a deeper probing into the concept of *presence* – the idea of 'being with' is mediated by technology and suggests a social identity. The script and subsequent narrative of the patient-provider interaction is not only influenced by human factors, but conversely it is also mediated by technological and environmental factors such as equipment functionality and the physical attributes of at least two healthcare sites (the site where the patient is located and the provider's site). Described succinctly, *transactional presence* in a telemedicine primary healthcare encounter is *purposeful human action-interaction within mutual (patient-provider) perceptions of being fully involved and*

engaged with one another and the technological factors affecting the telemedicine encounter itself.

In primary care telemedicine encounters, the construct of *transactional presence* helps to prioritize the idea of a purposeful 'being with' in which patients and providers are brought together by/through the videoconference medium for the purpose of effective healthcare. It also incorporates the concepts of social presence and richness, immediacy, realism, transportation, immersion, and medium as influencing factors – the focal point of this discussion.

Telemedicine Communication Matrix

The Telemedicine Communication Matrix (TCM) represents the complexity of a technologically mediated primary care telemedicine encounter, and provides a way of visualizing the components of *transactional presence* (Appendix A). At the same time, the matrix suggests a paradoxical simplicity. The matrix is arranged into three 'umbrella' dimensions followed by categories and finally factors. Moreover, each section (from dimensions to factors) increases in complexity. It would be difficult indeed for any one person to monitor all aspects of the elements represented in the matrix. Yet if we are mindful of the dimensions, categories, and factors, we believe that the likelihood for communication effectiveness (and improved healthcare outcomes) will increase. The matrix offers a set of *dimensions*, *categories*, and *factors*, to support considerations of how best to construct and/or analyze and evaluate a mediated communication event.

Research Methods

Our research design and survey questions are based on prioritizing the human dimension of medicine; specifically, by focusing on categories and factors that influence the perception of patients and providers of *transactional presence* in a primary care telemedicine encounter.

We began the chapter by disclosing our belief that connectivity was no longer the major issue in telemedicine. We strive to achieve the best connections possible with the highest quality sound and visual displays – the reality is that telemedicine may take place in sub-ideal conditions. For example, for some indigent patients, telemedicine may be the only clinical care available through a county clinic. That county indigent clinic may have a converted exam room serving as the telemedicine 'space' – the exam room may be very adequate for face-to-face primary care encounters but lacking in terms of lighting or acoustics for telemedicine. However, the county budget is no doubt insufficient to 'fix' the space used for telemedicine. Thus, providers need to develop personal skills to overcome sub-ideal conditions in order to provide care to populations that: 1) do not have a county healthcare provider available; and, 2) can't afford transportation to a state hospital or clinic. Consequently, while it might be desirable to paint the room or upgrade otherwise adequate lighting, primary care telemedicine will often be conducted in sub-ideal, but functional, technical environments. Therefore, we focus our research on the *human dimensions* of the Telemedicine Communication Matrix, in order to consider how providers can overcome the 'filtered' visual and verbal elements

For our research, we videotaped four telemedicine clinical encounters between the University of Texas Medical Branch (UTMB) in Galveston, TX and several distant clinics that have existing contracts for telemedicine services. Three different healthcare

providers and four different patients formed the subject matter for this study of *transactional presence* and patient-provider communication.

Telemedicine Encounter One: Provider on-site at UTMB and white female at a distant clinic for follow-up on allergy medication. Overall encounter time: 7 minutes.

Telemedicine Encounter Two: Provider on-site at UTMB and white female at a distant clinic with gastro-intestinal pain as her presenting problem. Overall encounter time: 28 minutes.

Telemedicine Encounter Three: Provider on-site at UTMB and black male (with wife and child in attendance) at a distant clinic for follow-up / adjustment of seizure medication. Overall encounter time: 17 minutes.

Telemedicine Encounter Four: Provider on-site at UTMB and white female at a distant clinic with skin irritation as her presenting problem. Overall encounter time: 20 minutes.

The videotapes were digitized and transcripts were made of the verbal interaction that took place during the encounters. In addition, two groups of patients – those who had previously experienced at least one primary care telemedicine encounter and those who only viewed the digitized telemedicine encounters described above, were included in these studies. Patient and provider permissions were obtained in accordance with the IRB protocols established for this project (IRB #01-223 and #03-364).

This research study occurred at two separate locations (The University of Texas Medical Branch, Galveston, TX and Alverno College, Milwaukee, WI), and used different evaluation approaches as described below; however, the findings of our research are combined and reported by the themes that emerged.

Study Group One: Telemedicine patients: UTMB – Galveston, TX

Patients who had experienced at least one telemedicine primary care encounter were asked to respond to a set of questions designed to assess the affect of telemedicine on the patient-provider relationship (n = 20). While telemedicine patients routinely complete a satisfaction survey at the conclusion of their visit, this survey was the first attempt to evaluate the impact of telemedicine on patient-provider relationships. This group completed a survey and responded to interview questions at their remote site immediately following their telemedicine visit. Participants answered numerous questions relating to concerns about trying telemedicine, the relationship they have with the doctor, and their overall satisfaction.

Study Group Two: Primary care patients: UTMB – Galveston, TX

A focus group made up of patients who had no experience with a telemedicine encounter, were asked to view the digitized tapes and then to respond to a set of structured questions specifically looking for elements of providers' verbal and nonverbal behaviors that encouraged (not inhibited) the development of patient-provider relationships (n = 7). Prior to viewing the tapes, this group was first challenged to recall their last clinic visit with their primary care provider and to describe what physician behaviors encouraged the development of a close patient-provider relationship. Viewing of the digitized tapes followed this discussion. During the focus group, one of the tapes were replayed a second time with the sound turned off in order to assess the nonverbal interaction between patient and provider.

Study Group Three: Primary care (telemedicine) providers: UTMB – Galveston, TX

A focus group of primary care providers who are regularly scheduled to conduct telemedicine 'visits' to remote clinics were asked about their perceptions of communication factors and preferences association with quality patient-provider interactions (n = 5). Providers were initially asked to reflect on what occurred during their face-to-face clinic visits with patients, and then to compare the differences and similarities to telemedicine visits. The healthcare providers (physicians, physician assistants, and registered nurses) were asked questions regarding their decision-making ability, the relationship with patients, and their comfort level with telemedicine.

Study Group Four: Undergraduate & Graduate Students: Alverno College, Milwaukee, WI

Two groups of students were asked to complete the *Transactional Presence Research Project* (TPRP): a qualitative research approach that focused on gathering and investigating students' perceptions of *transactional presence* between provider and patient based on the textual transcript of one taped telemedicine encounter. Specifically, the textual (transcript) analysis focused on the *human dimension*, *verbal category*, and *language factor*, i.e., the actual 'transcripted' dialogue between patient and provider during the telemedicine encounter. The broad intent centered on identifying patterns, and considering implications for developing and/or increasing *transactional presence* in primary care telemedicine encounters. The visual response shifted to the *technological dimension* of the TCM, the *communication tool category*, and *medium factor*, i.e., video image display conveyed through camera field of view (extreme long shot: ELS – the 'full' person(s) and a lot of the room can be seen; long shot: LS – the 'full' person(s) and some of the room can be seen; medium shot: MS – person can be seen from waist or chest up; close up: CU – the person can be seen from neck up or a specific part of the person can be

seen; and, extreme close up: ECU – part of the person's face or a specific part of the person can be seen.

Undergraduate professional communication students were asked to complete the TPRP (n = 10). They completed a textual analysis of the transcript, identifying within the patient-provider dialogue moments of *transactional presence*, if any. In pairs, students discussed and came to agreement on key moments of perceived transactional presence. Then each pair of students prepared a storyboard with field of view camera shots, depicting the patient and provider during the key moments of transactional presence. After all storyboards were completed, students viewed a digitized version of the telemedicine event, compared the actual field of view camera shots with their storyboard representations, noted any differences in their perceptions of presence, and ranked (high, medium, or low) the perceived quantity and quality of *transactional presence* in the telemedicine encounter. In a debriefing session, students discussed their analyses and perceptions as well as offered suggestions for increasing transactional presence in similar telemedicine encounters.

Graduate instructional design students were also asked to complete the same *Transactional Presence Research Project* (n = 12). Additionally the graduate students were asked to make written recommendations for developing and/or increasing *transactional presence* in primary healthcare telemedicine encounters.

The textual-transcript analyses, storyboards, recorded discussions, and written recommendations from both groups were examined and compared for interpretation and response patterns linked to quality factors associated with *transactional presence.*

Study Group Five: Undergraduate Nursing Students and Registered Nurse Monitors:

Alverno College - Milwaukee, WI

Undergraduate nursing students and Registered Nurse monitors were asked to complete a textual (transcript) analysis designed to gather perceptions about language content (verbal/nonverbal) from the respective perspective of novice and experienced healthcare providers (n = 7).

The design for the transcript analysis drew upon communication skill set clusters from Brammer and MacDonald[28] to identify perceptions of presence between patient and provider in a primary care telemedicine encounter. Specifically, they were asked to code the following skill set clusters: listening, reflecting, confronting, and interpreting along with an 'other' category. The coding was analyzed to determine participates' perceptions of patient-provider *presence*. The transcript survey for nursing education participants also focused on the TCM *human* dimension. Based on a close reading of the transcript, participants considered the factors of (verbal) language, (relational) roles, and types of actions/transactions that occurred.

The overall intent of this part of the project was twofold – to identify communication patterns that were effective when using a teleconferencing medium; and, to identify specific skill clusters that were perceived as valuable in a primary care telemedicine encounter.

Findings and Discussion

The Telemedicine Communication Matrix (TCM) provided the organizing structure for our studies, and we will point to outcomes within the *Dimensions*, *Categories*, and *Factors* wherever relevant. Our research design utilized quantitative and qualitative

methods. Follow-up interviews, written surveys, and focus groups, provided some significant insights into the primary care telemedicine encounter. We grouped the overall findings from these five discrete studies by themes. Analysis of the perceived impact of telemedicine on patient-provider communication, and development of relationships during primary care clinical encounters, were the focus of Study Groups 1, 2 and 3. Study Groups 4 and 5 used the verbal transcripts to discover moments of *transactional presence*, and confirmed their findings with the digitized videotape.

<u>Written Response Surveys – A Starting Point</u>: In the written survey, patients rated their overall *comfort* level with telemedicine as 95.25%, while providers ranked this item as 92.5%. When both groups were asked to then compare their telemedicine experience to a traditional face-to-face visit, patients reported a *satisfaction* level on that question of 61.25% while providers reported 71.07%. On a global question of satisfaction, all participants rated their satisfaction level at 90% or above. Patients in this survey all felt that telemedicine did not affect the interpersonal relationship with their healthcare provider. Healthcare providers judged that telemedicine did not impact the relationship with patients; and, all reported spending about the same amount of time with patients using telemedicine as with patients in the clinic.

<u>Focus Groups – In-Depth Follow-up</u>: We then took these survey results to a focus group in order to help us understand the difference between the high global satisfaction with telemedicine and the discrepancy that appeared when the question was phrased: "compared to a regular visit…." It was during these conversations with patients and healthcare providers in Study Groups 2 and 3 that we discovered the impact that specific behaviors – the human element, had on primary care telemedicine encounters. In addition

to the survey results, we utilized the videotaped telemedicine encounters to set the context and further stimulate discussion.

Focus group participants first commented on the impact of everyday nonverbal behaviors that usually go unnoticed, but became amplified through the telemedicine encounter. Participants pointed out how patients in the videotapes seemed more animated and distractions appeared 'on tape' where they wouldn't be noticed in day-to-day meetings; for example, a healthcare provider 'played' with her hair during conversations with the patient and 'busy-ness' of hands and shifting posture of the patient became annoying. They further observed that eye contact appeared to be very low in comparison to a face-to-face encounter. While providers often refer to the patient's chart during a face-to-face clinic visit, that behavior became extremely distracting 'on tape'. The focus group discussion continued concerning the amount of reduced visual information that a provider receives on a patient through the camera, and therefore relies more heavily on the patient's medical record. Conversely, a patient 'sees' less and has fewer visual cues to assess what is actually taking place. These discussion tracks lead to an expression of underlying feeling of potential abandonment by patients. Although no specific examples could be cited, patients felt that they could possibly be cutoff at any time by the provider, and/or the technology.

Perhaps most insightful were comments on the patient-provider interaction itself. Focus group participants again commented on the reduced 'information' available from visual sources during a telemedicine encounter (compared to a face-to-face visit). Consequently, they felt that first impressions were often reserved until after the verbal interactions began – the sound of the provider's voice, and the manner and kinds of

questions were most important to patients when considering *transactional presence*. Yet patients also observed less 'small talk' and a reduced socialization processes during telemedicine visits – providers appeared to get-down-to-work almost immediately. Additionally, the focus group participants were split on the perceived need for a 'physical' connection with the provider. For example, a patient/provider handshake at the beginning of a clinic visit, or a patient being handed a prescription (the physical giving and receiving of a slip of paper) at the conclusion of the visit.

Focus group participants who were healthcare providers (Study Group 3) commented that they behaved more conservatively when utilizing telemedicine – they felt less in control of both their time and the direction of their history-taking; they felt they talked 'differently' (and less) to telemedicine patients; they explored fewer collateral issues apart from the presenting problem; and, they felt they couldn't afford to 'open a can of worms' because they only had 'verbal control' (vs. verbal and non-verbal control) over the direction of the visit. Additionally, providers acknowledged that they ordered more tests and provided more referrals when seeing patients through telemedicine encounters then in face-to-face visits. The final comment by one of the physicians summed up the observations of this group: "I think it is a matter of knowing which patients and conditions are appropriate for this type of service."

Transactional Presence – Assessing Interactions: Despite the personal concerns expressed by both patients and providers during this critical analysis, we found objective evidence of *transactional presence* in each of the videotaped primary care telemedicine encounters.

In critical readings of the telemedicine transcripts, both the undergraduate and graduate students (Study Group 4) identified four to six moments of 'agreed upon' perceived *transactional presence* within the patient-provider dialogue. Overall, compiled team ratings for the perceived quantity and quality of *transactional presence* in the telemedicine encounter averaged a medium rating (neither high nor low). Sketches of the camera's field of view indicated that key affective moments of transactional presence, i.e., moments of emphasis, were optimal when the camera allowed for 'bonding' through a CU display image– the person can be seen from the neck up, and when eye contact was sustained – provider looking at the camera and not the monitor. Other key moments of *transactional presence* that were more casual, i.e., with less emotional under/overtones or less emphatic, were typically sketched with a MS display image – the person can be seen from waist or chest up.

Similarly, Study Group 5 coded the transcript of the third telemedicine encounter, in an effort to identify communication behaviors used by the healthcare provider to establish and sustain a working relationship with the patient (and in this scenario, his wife). There was a sure sense of engagement evident in the communication behaviors that were used throughout the patient appointment.

Listening skills. The healthcare provider used active listening phrases in response to the patient's description of his medical problem, and questions were asked in a reflecting mode in order to gather information that was more descriptive and to check the accuracy of perceptions of the meaning of the information. For example, early in the interaction the healthcare provider questioned whether the patient might have forgotten to take his medication. He responded that he had taken it as ordered. His wife added

information that he had also taken a second prescription medication and she wondered if that was a correct thing to do.

Reflecting skills. The healthcare provider heard the response, presented her interpretation of the behaviors and then allowed for perception-validation when she stated "...and I think taking (the drug) before you go to bed, if that's helping...that's good...." Later in the interaction, the patient asked about an intervention he saw on television. The healthcare provider listened to the idea and then used reflection and interpreting behaviors to respond.

Confronting skills. The healthcare provider suggested some reasons why the TV-therapy would not be feasible in this instance and returned to the patient's use of the previously discussed medication and interpreted how it worked in managing the patient's symptoms.

Interpreting skills. There was some discussion of the need to increase the medication and that brief exchange appeared to be used by the patient's wife as an invitation to ask about a concern she had in taking care of her husband. The healthcare provider asked a question or two (suggesting listening) and then stated, "Well I'm thinking though...." as she went on to interpret the information in relation to the client's medical condition and presenting needs. It is at this point in the telemedicine encounter, a little more than mid-way through the appointment, that the interaction suggested a real sense of *transactional presence*. The healthcare provider, patient and his wife exchanged ideas, reinforced each other's suggestions and responses, and developed a workable plan that was agreeable to all. A tangible sense of partnership was reflected in the dialogue of the interaction at this point and was sustained to the end of the appointment.

Summary

Once optimal technical connectivity is accomplished between patient- and provider-sites, and the most favorable clinic environment is established to conduct primary care telemedicine, there remains the human dimension of the transaction to consider. 'Simply' replicating what transpires in a face-to-face primary care office visit, during a telemedicine encounter, will most often lead to a lowered satisfaction level for both patients and providers. Consequently, in addition to technical connectivity, we feel that consideration needs to be given to the visual, auditory, and social filters associated with the technology that affect the patient-provider relationship. In addition, we believe that the dialogue between patient and provider is the lynchpin to the effective delivery of primary care telemedicine. As we stated earlier, we find this concept is embodied in the framework developed by Habermas[9,10] in which communication is considered directional – patients have the responsibility to 'move' the dialogue along toward an answer to their medical questions so that they develop an understanding of the issues; physicians have the responsibility to 'move' the discourse toward a resolution of the presenting problem.

The *Study of Human Factors* model (Docktor & Bangert) provides a framework to address the complexity of providing telemedicine in diverse environments. The model proposes layers of considerations influencing human dynamics in an e-health context. In each of the layers of the 'onion' are imbedded mental models, supposition and expectations – exposing, exploring and examining each in turn, along with the *dimensions*, *categories* and *factors* that cross the boundaries of those layers, will bring about thoughtful consideration of the significance of telemedicine. Striving for a close

transactional presence between patient and provider in a primary care telemedicine encounter emphasizes the importance of the human dimension of telemedicine.

From our exploration of *transactional presence* and consideration of the overall patient-provider relationship, we make the following prescriptive observations that could improve communication, develop true patient-provider relationship, and overcome technological and environmental 'filters' in a primary care telemedicine encounter::

Verbal Categories: Social 'small talk' at the beginning of the telemedicine encounter provides an opportunity to develop a conversation between patient and provider, and to overcome the sense of potential abandonment identified by telemedicine patients. Specific attention to verbal interaction: tone of voice, style of questions asked, and 'wait time' – a meaningful pause to allow a patient to respond, are approaches to enhancing patient-provider relations.

Non-Verbal Categories: Ensure camera placement allows for patient eye contact even as the provider looks at the monitor to 'see' the patient rather than looking into the camera. Utilize close-up shots of the patient as well as of the provider to support diagnosis and a sense of 'bonding'. Additionally, being *present* was interpreted as a forward-leaning posture; being *distant* was interpreted as sitting back, unengaged, and giving the impression of 'let's finish this'.

Relational Categories: Providers should acknowledge to patients that "I'm looking at ...." when consulting an off-camera electronic medical record or other patient chart. Similarly, since ALL behaviors are amplified during a telemedicine encounter, a provider should acknowledge to a patient that "I'm thinking about....." instead of reflecting in

silence. This directionality in communication includes the patient in the process, thereby improving *transactional presence.*

Actions/Transactions Categories: Conscious attention to the basic characteristics associated with active listening provide a sense of purposeful 'being with', essential behaviors for the development of *transactional presence* and the patient-provider relationship.

The human dimension of telemedicine is, we believe, the most important of the various elements in the Telemedicine Communication Matrix – it is the component of the transaction over which healthcare providers have some measure of control. We associate our TCM dimensions primarily with the *Actors, Network and Alliance* layer of *The Study of Human Factors* Model (Doktor & Bangert). The concepts of *Actor* and *Alliance,* when aligned with the Human Dimension of the TCM, suggest that healthcare providers may find it beneficial to 'view' themselves in the lead role of the healthcare narrative. By doing so, providers can begin a reflective and pragmatic consideration of how their character and performance influence patient perceptions of 'being with' during primary care telemedicine encounters. They may also begin to recognize and to encourage a reciprocal response from their telemedicine patients. The TCM offers a framework for designing the telemedicine 'stage', choreographing the human performance, and constructing the healthcare narrative. Consequently, we believe on-going research is needed to further examine the role and to evaluate the influence of the specific factors in the Telemedicine Communication Model as one means for determining appropriate mental models, for exploring the full range of telemedicine suppositions, and for

improving overall acceptance and utilization rates. The goal is to create guidelines for creating a personal *transactional presence* in a telemedicine encounter.

Appendix A

Telemedicine Communication Matrix

Dimensions	*Categories*	*Factor*
Human	***Verbal*** (spoken & written)	***Specific Language*** (conventions, word choice, message structure, etc.)
Individual: patient & provider Interpersonal: between patient & provider, which may include advocate and /or mid-level presenter with the patient and a primary care provider	***Nonverbal***	***Appearance, Movement & Expression*** (touch, gesture, facial, eye, vocalic, etc.)
	Relational	***Roles & Culture*** (socially prescribed, individually enacted)
	Actions/Transactions (patient/provider behaviors)	***Type & Sequence*** (specific behaviors that create a healthcare narrative, including intuition-based behaviors)
Technological (tools)	***Medical Artifacts/Tools*** (diagnostic, e.g., stethoscope, records)	***Quantity Quality, & Use*** (amount, types, & functionality)
	Communication Artifacts/Tools (videoconference, computer, telephone systems)	***Quantity, Quality, Use, & Medium*** (amount, types, & functionality, image-sound display) qualities & integration, etc.)
Environmental (places integral to the telemedicine event)	***Physical Place*** (two or more sites associated with healthcare event)	***Pragmatic & Affective*** (use of space, appearance, temperature, comfort, etc.)
	Mediated Place (social context)	***Immediacy & Presence*** (physical presentation & psychological perception of togetherness)

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Send reply to: "Bob Doktor" <doktor@cba.hawaii.edu>
From: "Bob Doktor" <doktor@cba.hawaii.edu>
To: <DBangert@hawaii.edu>
Copies to: "Michael" <mvaldez@cba.hawaii.edu>
Subject: **Re: section 6**
Date sent: Mon, 12 Jan 2004 09:51:28 -1000

----- Original Message -----
From: "David C. Bangert" <DBangert@hawaii.edu>
To: <doktor@cba.hawaii.edu>
Sent: Monday, January 12, 2004 7:37 AM
Subject: FW: section 6

>
>
> David C. Bangert
> 808 293 2981
> The College is changing its email system.
> My preferred email is now: DBangert@hawaii.edu
>
> -----Original Message-----
> From: ephost@epnet.com [mailto:ephost@epnet.com]
> Sent: Saturday, January 10, 2004 7:30 AM
> To: dbangert@hawaii.edu
> Subject: section 6
>
> ______
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> Record: 1
>
> Title: Examining the Technology Acceptance Model Using Physician
> Acceptance of Telemedicine...
> Author(s): Hu, Paul J.
>
> Chau, Patrick Y.K.
> Source: Journal of Management Information Systems; Fall99, Vol.
> 16 Issue 2, p91, 22p, 5 charts, 2 diagrams
> Document Type: Article
> Subject(s): *INFORMATION resources management
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> *INFORMATION technology
>
> TELECOMMUNICATION in medicine
> Abstract: The rapid growth of investment in information technology
> (IT) by organizations worldwide has made user acceptance an increasingly
> critical technology implementation and management issue. While such
> acceptance has received fairly extensive attention from previous
> research, additional efforts are needed to examine or validate existing
> research results, particularly those involving different technologies,
> user populations, and/or organizational contexts. In response, this
> paper reports a research work that examined the applicability of the
> Technology Acceptance Model (TAM) in explaining physicians' decisions to

> accept telemedicine technology in the health-care context. The
> technology, the user group, and the organizational context are all new
> to IT acceptance/adoption research. The study also addressed a pragmatic
> technology management need resulting from millions of dollars invested
> by healthcare organizations in developing and implementing telemedicine
> programs in recent years. The model's overall fit, explanatory power,
> and the individual causal links that it postulates were evaluated by
> examining the acceptance of telemedicine technology among physicians
> practicing at public tertiary hospitals in Hong Kong. The authors'
> results suggested that TAM was able to provide a reasonable depiction of
> physicians' intention to use telemedicine technology. Perceived
> usefulness was found to be a significant determinant of attitude and
> intention but perceived ease of use was not. The relatively low R-square
> of the model suggests both the limitations of the parsimonious model and
> the need for incorporating additional factors or integrating with other
> IT acceptance models in order to improve its specificity and explanatory
> utility in a health-care context. Based on the study findings,
> implications for user technology acceptance research and telemedicine
> management are discussed. [ABSTRACT FROM AUTHOR]
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> href="http://search.epnet.com/direct.asp?an=2635310&db=buh">Examining
> the Technology Acceptance Model Using Physician Acceptance of
> Telemedicine...</A>
>
> Database: Business Source Premier
> EXAMINING THE TECHNOLOGY ACCEPTANCE MODEL USING PHYSICIAN ACCEPTANCE OF
> TELEMEDICINE TECHNOLOGY
>
>
>
> ABSTRACT: The rapid growth of investment in information technology (IT)
> by organizations worldwide has made user acceptance an increasingly
> critical technology implementation and management issue. While such
> acceptance has received fairly extensive attention from previous
> research, additional efforts are needed to examine or validate existing
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> user populations, and/or organizational contexts. In response, this
> paper reports a research work that examined the applicability of the
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> practicing at public tertiary hospitals in Hong Kong. Our results
> suggested that TAM was able to provide a reasonable depiction of
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> utility in a health-care context. Based on the study findings,
> implications for user technology acceptance research and telemedicine
> management are discussed.
>
> KEY WORDS AND PHRASES: information technology acceptance, information
> technology management in health care, Technology Acceptance Model,
> telemedicine.
>
> INFORMATION TECHNOLOGY (IT) HAS BECOME AN INTEGRAL, EVEN A PIVOTAL, PART
> of business activities and processes undertaken by an organization. As
> investments in IT by organizations all over the world continue to grow
> at a rapid pace, user technology acceptance has become an increasingly
> critical technology implementation and management issue [19, 26, 39,
> 47]. However, regardless of potential technical superiority and promised
> merits, an unused or underutilized technology cannot be effective [47,
> 48]. As Davis et al. [23] comment, "As technical barriers disappear, a
> pivotal factor in harnessing this expanding power of computer technology
> becomes our ability to create applications that people are willing to
> use."
>
> User technology acceptance has received fairly extensive attention from
> information systems (IS) researchers and practitioners [2, 9, 10, 23,
> 30, 39, 47, 52]. The issue has been examined across assorted information
> technologies and user populations, and a fairly satisfactory empirical
> support for respective theories or models investigated has been
> accumulated. Of the models that have been proposed and examined, the
> Technology Acceptance Model (TAM), originated by Davis [20], appears to
> be the most promising. TAM is an intention-based model developed
> specifically for explaining and/or predicting user acceptance of
> computer technology. TAM has been used as the theoretical basis for many
> empirical studies of user technology acceptance/adoption [1, 11, 12,
> 21, 23, 48, 64, 65, 66] and has accumulated ample empirical support.
>
> In spite of the documented empirical applicability of TAM, additional
> efforts are needed to validate existing research results, particularly
> those involving different technologies, users, and/or organizational
> contexts, in order to extend the model's theoretical validity and
> empirical applicability. This study emerged as a response to the call
> for more empirical validation of well-researched theories/models in
> different settings. In particular, we examined TAM in the context of
> physician acceptance of telemedicine technology. The study aims to make
> a contribution to IT acceptance/adoption research by advancing the
> understanding of user technology acceptance and extending the
> theoretical validity and empirical applicability of existing literature
> to health-care professionals, who have become increasingly dependent on
> IT [59]. Furthermore, addressing the issue of physicians' technology

> acceptance can fill a research void as well as meeting a pragmatic need
> for managing telemedicine technology by health-care organizations where
> considerable growth in IT investment and utilization has occurred [55].
>
>
>
> Literature Review and Research Motivation
>
>
> USER TECHNOLOGY ACCEPTANCE HAS RECEIVED FAIRLY EXTENSIVE attention from
> information systems (IS) researchers and practitioners [2, 23, 30, 39,
> 47]. Collectively, the literature has suggested that user acceptance is
> a critical success factor for IT adoption and can be sufficiently
> explained, accurately predicted, and effectively managed by means of a
> host of relevant factors. In particular, these factors include three
> important dimensions: characteristics of the individual, characteristics
> of the technology, and characteristics of the organizational context.
> Various frameworks and models have used these characteristics to
> investigate the nature and determinants of IT acceptance/adoption.
> Examples include Rogers's [57] diffusion of innovations model, Kwon and
> Zmud's [42] diffusion/implementation model, and Davis's [21]
> technology acceptance model (TAM). Saga and Zmud [59] reviewed prior IT
> acceptance studies and identified twenty empirical studies that aimed at
> investigating the nature and determinants of IT acceptance. Among these,
> TAM was found to be one of the most influential. Compared with other
> frameworks/models, TAM has advantages in parsimony, IT specificity,
> strong theoretical basis, and ample empirical support.
>
>
> TAM and Related Empirical Studies
>
>
> TAM was developed by Davis [20] to explain computer-usage behavior. The
> theoretical grounding for the model is Fishbein and Ajzen's [24] theory
> of reasoned action (TRA). According to TRA, beliefs influence attitudes,
> which in turn lead to intentions, which then guide or generate
> behaviors. TAM adapts this belief-attitude-intention-behavior
> relationship to an IT user acceptance model. The goal of TAM is to
> "provide an explanation of the determinants of computer acceptance that
> is general, capable of explaining user behavior across a broad range of
> end-user computing technologies and user populations, while at the same
> time being both parsimonious and theoretically justified" [23,p. 985].
>
> Many studies have examined TAM's overall explanatory power and
> measurement validity in different empirical settings characterized by
> user group, technology, and organizational context. For instance, quite
> a few empirical studies of TAM have tested the theory with students as
> the user group. Davis et al. [23] longitudinally investigated the
> validity of TAM and TRA in M.B.A. students' acceptance of a word
> processor application. Mathieson [48] compared the utility of TAM and
> Theory of Planned Behavior (TPB) [41], another theory that extends from
> TRA but does not specifically target IT acceptance/adoption behavior, in
> predicting intention of undergraduate students to use a PC-based
> spreadsheet application. In another longitudinal study, Taylor and Todd

> [65] examined the validity of TAM together with TPB in explaining and
> predicting the use of a computer resource center by business school
> students. Recently, Szajna [64] evaluated TAM in an investigation of
> acceptance of an e-mail system by graduate students at a business
> college.
>
> The model has also been examined by nonstudent subjects. For example,
> Davis [21] tested TAM using acceptance of an e-mail system and a word
> editor by employees at a large commercial organization. Using an
> extended TAM, Chau [11] investigated acceptance of a newly released
> PC-based application suite by administrative and clerical staff at a
> university. In another study, Chau [12] examined a modified TAM using
> acceptance of computer aided software engineering (CASE) technology by
> system developers. Recently, Igbaria et al. [37] investigated personal
> computing acceptance factors in small firms using TAM as the theoretical
> basis.
>
> Jointly, results from these and other studies suggest that TAM is
> capable of providing fairly adequate explanation and/or prediction of
> user acceptance of IT. While perceived usefulness has been identified as
> consistently important in attitude formation, support for perceived ease
> of use has been inconsistent and of less significance. As suggested by
> the literature, a plausible explanation for the observed differential is
> that the importance of perceived ease of use as a determinant of the
> intention to use a technology may become insignificant after users'
> prolonged exposure to the technology [11].
>
> The validity of measurement scales for TAM has also been scrutinized.
> Adams et al. [1] examined the psychometric properties of the perceived
> usefulness and perceived ease of use scales employed by Davis [21] by
> replicating his study. Similarly, Hendrickson et al. [32] assessed the
> reliability of perceived usefulness and perceived ease of use by
> investigating user acceptance of two software packages. The reliability
> and validity of the measurement scales for TAM were also examined by
> Segars and Grover [60].(n1) Collectively, the literature has suggested
> relatively high reliability and validity for both measurement scales.
>
> Our literature review indicates that TAM would be valuable and useful
> for explaining or predicting user acceptance of IT, particularly among
> students and end users and executives in a university or business
> organization context. However, the validity of the model has rarely been
> tested with professionals such as physicians or attorneys in their own
> professional contexts. Conceivably, such professionals may differ from
> students or other subjects commonly studied by previous research due to
> a host of factors including general competence, intellectual and
> cognitive capacity, specialized training, and professional work and
> accomplishments. Hartwick and Barki [29] emphasize the increasing
> importance of theory testing for IS research, for which examination or
> validation of existing findings of user technology acceptance is
> desirable, particularly when the findings involve different
> technologies, user populations, or organizational contexts.
>
> This study examined TAM in a professional setting, investigating the
> factors affecting physicians' acceptance of telemedicine technology.

> Choice of TAM over other IT acceptance/adoption models was made for the
> following reasons. First, TAM is general, parsimonious, IT-specific, and
> designed to provide an adequate explanation for and a prediction of a
> diverse user population's acceptance of a wide array of IT within
> various organizational contexts. Second, TAM has a well-researched and
> validated inventory of psychometric measurements, making its use
> operationally appealing. Finally, TAM is a dominant model for
> investigating user technology acceptance and has accumulated fairly
> satisfactory empirical support for its overall explanatory power, and
> has posited individual causal links across a considerable variety of
> technologies, users, and organizational contexts [11, 12, 23, 48, 64].
>
>
> Telemedicine Acceptance Studies
>
>
> Telemedicine is an IT-based innovation that has the potential to support
> and enhance physicians' patient care as well as to improve health-care
> organizations' competitiveness. The concept of telemedicine emerged
> almost four decades ago when rudimentary pioneering projects were under
> way, driven by futuristic quests that primarily focused on concept
> proving or feasibility evaluation [38, 71]. Most early telemedicine
> endeavors failed to meet expectations, however. Problems included
> nascent and mostly primitive IT infrastructure, immature technology and
> inefficient technology use, and premature funding termination [7]. As
> summarized by Bashshur et al. [7], the failure of the first-generation
> telemedicine projects demonstrated the need for detailed consideration
> and rigorous evaluation of the multitude of technological, social,
> cultural, and organizational dimensions accompanying the introduction of
> telemedicine. User technology acceptance is an essential organizational
> challenge facing health-care organizations considering or planning to
> provide telemedicine-enabled health-care services.
>
> Previous telemedicine research has predominantly focused on
> technological developments or clinical applications [54, 62, 68, 69,
> 70] and thus offers limited discussion of physician technology
> acceptance. A handful of studies have investigated physician technology
> acceptance [3, 27, 45, 46, 50], but most of these were limited in scope
> and scale, as measured by medical specialty and sample size,
> respectively. As summarized by Mitchell et al. [50], earlier
> investigations of user acceptance of telemedicine technology typically
> had a small and restrictive sample size and tested hypotheses that were
> idiosyncratically formulated without theoretical foundation. Therefore,
> integrating user technology acceptance literature and telemedicine
> research and management needs represents a desirable and advantageous
> opportunity to validate the existing IT acceptance/adoption literature
> by examining physician acceptance of telemedicine technology. One
> logical starting point is to use TAM, a dominant model in the
> literature, to provide a necessary theoretical basis. The choice of
> telemedicine technology acceptance by physicians as the research context
> was justified by the significance of the health-care sector in national
> and global economies, the fast-growing IT investment by health-care
> organizations, and the unique characteristics of health-care
> professionals, which in combination represent a desirable extension to

> existing research on user technology acceptance.
>
>
> Research Model, Design, and Method
>
>
> Research Model
>
>
> Figure 1 depicts the research model employed in the study. It is a
> reduced TAM model, excluding actual behavior. Behavior intention is
> predicted by both attitude and perceived usefulness; the latter also
> influences attitude. Perceived ease of use influences both attitude and
> perceived usefulness. In our context, the model hypothesizes that the
> degree to which telemedicine technology is easy to use, as perceived by
> physicians, affects both their perception of the usefulness of the
> technology and their attitude toward using the technology in general.
> Attitude is also influenced by the level of the technology's usefulness,
> as perceived by physicians. Finally, the intensity of physicians'
> intention to use a technology can be explained or predicted jointly by
> their attitude toward using the technology and the technology's
> perceived usefulness.
>
>
> Study Focus
>
>
> In this study, technology acceptance was defined as "an individual's
> psychological state with regard to his or her voluntary or intended use
> of a particular technology" [31]. The targeted technology was
> telemedicine in general, rather than specific telemedicine
> programs/technologies. The rationale was that telemedicine is mostly in
> an early adoption stage, which makes it difficult to conduct large-scale
> investigations of user technology acceptance based on a specific
> telemedicine technology. Nevertheless, the findings of the study can
> provide insights and implications relevant to technology acceptance
> research and telemedicine management in general. Quite a few prior
> studies have adopted this "broad" technology approach. Recent examples
> include Chau and Tam's [14] study on open systems and Arunachalam's [
> 5] work on electronic data interchange.
>
> User acceptance in this study was examined by intention to use the
> technology rather than actual usage [48, 64]. The decision was made
> primarily because telemedicine is still at an early development stage,
> characterized by limited technology adoption and use. The choice,
> however, was warranted from both research and managerial perspectives.
> On the research side, a number of prior empirical studies have reported
> a strong, significant causal link between behavioral intention and
> actual behavior [61]. Mathieson [48] has justified his use of
> behavioral intention as the dependent variable by stating that, given
> the strong causal link, "the fact that behavior was not directly
> assessed is not a serious limitation" (p. 186). On the management side,
> investigations of physician technology acceptance using a
> well-established theoretical foundation is of obvious importance and the

> use of behavioral intention as a dependent variable can be justified as
> a fast-growing number of health-care organizations interested in
> telemedicine are considering adopting or planning to adopt the
> technology.
>
>
> Subjects
>
>
> The study targeted physicians of preselected specialties who practiced
> in public tertiary hospitals in Hong Kong.(n2) Choice of targeted
> physicians was based on the likelihood of their current or potential
> involvement with telemedicine programs in the foreseeable future. As a
> group, physicians at public tertiary hospitals have substantial
> interorganizational service needs that may be greatly supported by
> telemedicine technology. In effect, all existing Hong Kong--based
> telemedicine programs involve public tertiary hospitals, which
> collectively provide more than 90 percent of tertiary care in Hong Kong
> [34]. Common interinstitutional service collaborations include
> solicitation of a second or a specialist's opinion, patient transfer or
> admission assessment, team-based collaborative patient management, and
> urgent medical care needs. As a result, physicians at these hospitals
> usually have up-to-date knowledge of innovative technologies and medical
> techniques and often exhibit high interest in experimenting with new
> technologies and pioneering their use.
>
> The choice of region was based on physician accessibility and the
> criticality of technology acceptance to program/project success.
> Compared with implementations elsewhere, physician technology acceptance
> appears to be increasingly important for Hong Kong--based programs [6,
> 43]. Relatively small geographic extent and acceptable resource
> requirements combined with emerging policies and regulations of
> telemedicine services and an across-the-board substantial government
> subsidy for health care reduce program implementation complexity and
> friction and have contributed to making physician technology acceptance
> increasingly important [44].
>
> A total of nine specialty areas were included in the study, selected
> because of their frequent and appropriate utilization of telemedicine
> and documented satisfactory results [53]. They included internal
> medicine, obstetrics and gynecology, pediatrics, psychiatry, radiology,
> pathology, accident and emergency, intensive care, and surgery.
>
>
> Instrument Development and Pretest
>
>
> Use of TAM to investigate physician technology acceptance is
> advantageous because of its well-researched and validated measurement
> inventory [21, 48, 60]. Specifically, preliminary measurements for
> perceived usefulness, perceived ease of use, attitude, and behavioral
> intention were obtained from prior studies [21, 23, 48] to formulate
> the question items, using a seven-point Likert scale with anchors
> ranging from strongly agree to strongly disagree.

>
> As most of the items were obtained directly from the literature, the
> validity of the instrument was reevaluated to ensure its applicability [
> 18, 63]. A review panel consisting of three physicians from different
> specialties was formed to evaluate the face and content validity of the
> instrument using a card-sorting method suggested by Moore and Benbasat [
> 51]. The results were satisfactory, as the physicians were able to
> categorize the question items presented with an accuracy rate of 90
> percent or better. To ensure desired balance of the items in the
> questionnaire, half of the question items were suitably negated to
> invite the attention of respondents who, as a result, might become
> increasingly alert to manipulated question items. In addition, all the
> question items were arranged in a random order to reduce the potential
> ceiling (floor) effect that could induce monotonous responses to
> question items designed to measure a particular underlying concept.
> Finally, to anchor the responses properly [36], the questionnaire
> provided a working definition of telemedicine and included reference
> materials containing information on and common examples of telemedicine
> technology. The review panel that assisted with the face and content
> validation was again invited to examine the formatted survey instrument
> to ensure that its layout and wording were appropriate in a health-care
> context.
>
> With satisfactory face and content validity established, the instrument
> was pretested for its reliability and construct validity [63]. A
> pretest was administered to thirty-five physicians from different
> specialties and hospitals. Results were fairly satisfactory, as
> manifested by acceptable Cronbach's alpha values (all above 0.70 [53])
> and relatively higher covariances among measurements for the same
> construct than for different constructs. The overall analysis suggested
> that the instrument was of adequate reliability and construct validity.
> A list of the measurement items included in the formal instrument is
> provided in the appendix. As shown, multiple measurements were used for
> each construct, complying with Churchill's recommendation to use a
> minimum of two indicators for a latent variable [16]. Physicians who
> took part in the pretest were excluded from the subsequent formal study.
>
>
>
> Data Collection Procedures
>
>
> Data were collected using a user-reported self-assessment approach [
> 17], deemed appropriate because of considerable literature support for
> its use in intention-based studies. Melone [49] suggested that the
> user-reported self-assessment approach was advantageous in situations
> where perceptual measures could cope with real-world constraints more
> effectively than could objective measures.
>
> A total of seventy clinical departments at the target hospitals were
> contacted by means of an encounter letter that briefly described the
> intended study. Personal visits and phone calls were later made to the
> departments' chiefs of service to provide detailed study information and
> solicit their voluntary participation. Forty-one of the seventy (59

> percent) departments agreed to participate.
>
> Questionnaire packets were delivered to physicians who practiced with
> the participating departments. Each packet contained a cover letter
> stating the purpose of the study and intended use of the data, along
> with endorsement letters from the Hong Kong Telemedicine Association and
> the Hospital Authority, selected telemedicine technology references, and
> the questionnaire.(n3) A letter soliciting internal promotion of the
> study was also faxed to chiefs of service of the participating
> departments immediately after questionnaire distribution to help promote
> the study and encourage participation. Subjects were asked to return the
> completed questionnaires to their department secretaries within two
> weeks of receiving the packet. Reminders and additional questionnaires
> were sent to physicians who failed to return a completed questionnaire
> before the specified deadline.
>
>
> Data Analysis and Results
>
>
> Sample Characteristics and Evaluation of Nonresponse Biases
>
>
> OF THE 1,728 QUESTIONNAIRES DISTRIBUTED, 421 WERE COMPLETED and
> returned, showing a 24.4 percent response rate. Thirteen of the returned
> questionnaires were partially completed and therefore were excluded from
> the data analysis, resulting in an effective response rate of 23.6
> percent. The respondents averaged 34.7 years in age and had 9.4 years of
> postinternship clinical experience in their respective specialty areas;
> the male-to-female ratio was approximately 4 to l; 80 percent of the
> respondents received their medical education in Hong Kong. Distribution
> of the respondents was fairly balanced among the participating
> hospitals, ranging from 6.5 to 11.6 percent. Similarly, distribution
> among the investigated specialties was fairly balanced, with the
> exception of radiologists and neurosurgeons, who exhibited relatively
> high interest in the study.
>
> Nonresponse is a potential source of bias in survey studies and
> therefore needs to be properly addressed [25]. The potential biases in
> this study were evaluated by comparing the responses between early and
> late respondents on the following two groups of measures: demographic
> data and responses to the question items for the four constructs in the
> research model. Early respondents were defined as those who had
> completed and returned the questionnaires within the initial two-week
> response window while late respondents were those who returned the
> questionnaires after the specified response period. Approximately half
> of the responses (203 out of 408) were from early respondents.
>
> The average ages for the early and late respondents were 35.9 and 33.4,
> respectively. No significant differences in postinternship clinical
> experience were observed between the two groups, which were largely
> comparable with respect to distribution of medical specialty, gender,
> and country where they attended medical school. As for responses to
> question items for the four constructs, as shown in Table 1, the

> differences were not significant, suggesting that the threat of
> nonresponse bias is not serious.
>
>
> Analysis of Measurement Validity
>
>
> Measurement validity in terms of reliability and construct validity was
> evaluated. Specifically, reliability was evaluated using Cronbach's
> alpha. As shown in Table 2, the values were either close to or above
> 0.70. Although the numbers were not as high as those obtained in some
> prior studies that had used the same items, they were in a range that
> was deemed acceptable, based on common threshold values recommended by
> the literature [53]. Nevertheless, since the items in the instruments
> were mainly adapted from existing literature, care should be exercised
> in interpreting the results.
>
> Construct validity of the instrument was evaluated by examining
> convergent and discriminant validity using both interitem correlation
> analysis and factor analysis.(n4) As summarized in Table 3, correlation
> was considerably higher among items intended for the same construct than
> among those designed to measure different constructs. This suggested
> adequate convergent and discriminant validity of the measurements.
>
> A principal component factor analysis was also performed. Four
> components were extracted, precisely matching the number of constructs
> included in TAM (Table 4). Furthermore, items intended to measure the
> same construct exhibited prominently and distinctly higher factor
> loadings on a single component than on other components, suggesting
> adequate convergent and discriminant validity of the measurement.
>
> Jointly, the observed reliability and convergent/discriminant validity
> suggested adequacy of the measurements used in the study.
>
>
> Model Testing Results
>
>
> The utility of TAM to explain and/or predict physician acceptance of
> telemedicine technology was examined using structural equation modeling
> [8, 35]. LISREL 8 with maximum likelihood estimation, which is
> appropriate for testing structural equation models that have a
> well-developed underlying theory [8], was used. The structural model
> was examined in terms of model goodness-of-fit, overall explanatory
> power, and postulated individual causal links.
>
> First, the overall model fit was assessed using multiple fit criteria,
> as suggested in the literature [30, 35, 60]. Specifically, seven
> goodness-of-fit indices were used, including chi-square/degree of
> freedom, goodness-of-fit index (GFI), adjusted goodness-of-fit index
> (AGFI), normalized fit index (NFI), nonnormalized fit index (NNFI),
> comparative fit index (CFI), and root mean square residual (RMSR). The
> chi-square statistic, which is also an intuitive index for measuring the
> goodness of fit between data and a model, was not used because of its

> sensitivity to sample size [13]. Table 5 summarizes the values observed
> in the study together with recommended values of common model fit
> indexes. As shown, even though some of them failed to meet the
> recommended minimum levels, they were close enough to suggest that the
> model fit was reasonably adequate to assess the results for the
> structural model.
>
> The explanatory power of the model for individual constructs was
> examined using the resulting R2 for each dependent construct. Together,
> perceived usefulness and perceived ease of use were able to explain 37
> percent of the variances observed in physicians' attitudes toward
> incorporating telemedicine technology in their services (figure 2).
> Perceived usefulness appeared to have contributed more to the observed
> explanatory power than perceived ease of use. At the same time, the
> combination of perceived usefulness of and attitude toward telemedicine
> accounted for 44 percent of the variances observed in physicians'
> intention to use the technology.
>
> The data also supported most of the individual causal paths postulated
> by TAM. Perceived usefulness had a significant direct positive effect on
> a physician's attitude as well as on his or her intention to use the
> technology, with standardized path coefficients being 0.45 and 0.36,
> respectively. Literally, these coefficients suggested that every unit
> increment in perceived usefulness would strengthen an individual's
> (positive) attitude by 0.45 unit and at the same time increase his or
> her intention to use telemedicine technology by 0.36 unit. Effects of
> attitude on intention were also significant and showed a 0.25 path
> coefficient. Thus, perceived usefulness had a direct as well as an
> indirect effect, through the mediating attitude, on intention to use,
> with a resulting total effect of 0.47. Perceived ease of use had
> positive effects on both attitude and perceived usefulness. However,
> neither of these was of statistical significance, contrary to what TAM
> suggests.
>
>
> Discussion
>
>
> THIS STUDY EXAMINED TAM USING PHYSICIAN ACCEPTANCE OF TELEMEDICINE
> technology. Based on data collected from 408 physicians, the utility of
> TAM for explaining acceptance of telemedicine technology by physicians
> was evaluated. The results suggested the general adequacy and
> applicability of TAM in this professional context as indicated by fairly
> reasonable goodness-of-fit indexes for the model. However, TAM's power
> to explain attitude and intention was limited compared with that
> reported by some prior studies that examined TAM in a "nonprofessional"
> context.
>
> In agreement with what TAM postulates, perceived usefulness was found to
> have a significant and a strong influence on physicians' intention to
> use the technology. This may suggest that physicians are relatively
> "pragmatic" and tend to focus on the usefulness of the technology
> itself. Therefore, for telemedicine technology to be accepted by
> physicians, it will be necessary to demonstrate its ability to fill the

> needs of individual physicians, who tend to treat technologies as tools,
> acceptable only when desired utilities in their practices have been
> proven. In this connection, providing proper user training is essential
> for directing and solidifying physicians' perceptions of the usefulness
> of the technology.
>
> Attitude was also found to be significant in influencing behavioral
> intention, though to a lesser extent than perceived usefulness. This
> suggests the relative importance of attitude in physicians' acceptance
> of telemedicine technology and its respective contribution in predicting
> behavioral intention.
>
> Contrary to what TAM hypothesizes, perceived ease of use was found to
> have no significant effect on attitude and perceived usefulness. This
> might reflect limitations of TAM's applicability with respect to
> technologies, user populations, or both. Physicians are professionals
> and may exhibit considerable differences in general competence,
> adaptability to new technologies, intellectual and cognitive capacity,
> and the nature of their work. In this connection, they differ from
> students or subjects ordinarily examined in previous research, including
> end users, administrative and clerical staff, knowledge workers, and
> system developers. Conceivably, physicians can assimilate a new
> technology quickly and become familiar with its operation without as
> intense training as might be necessary for other user populations.
> Another plausible explanation is that physicians might not want to spend
> time learning a new technology, even if it is very easy to use. This is
> especially true when the adoption and use of the technology might
> interfere with their traditional practice routines [4]. Telemedicine
> may require physicians to change their traditional longstanding practice
> patterns and, as a consequence, its perceived ease of use may not be
> considered an important issue. As Keil et al. [40] opined, "no amount
> of EOU (ease of use) will compensate for low usefulness" (p. 89). The
> finding suggests that TAM may not be appropriate for user populations
> who have considerably above-average general competence and intellectual
> capacity or have constant and reliable access to assistance in operating
> technology. The explanatory power of TAM, particularly the perceived
> ease of use factor, may weaken as the competency of the users increases.
>
>
> Compared with prior TAM studies, the model appeared to have relatively
> weaker utility for explaining physicians' attitude formation and
> intention development. Together, perceived usefulness and perceived ease
> of use accounted for only 37 percent of the variances in attitude, which
> is considerably less than that reported in Taylor and Todd (73 percent)
> [65] or Mathieson (73 percent) [48]. Similarly, combination of
> perceived usefulness and attitude explained 44 percent of the variances
> in intention to use the technology, which is also less than that
> reported by Szajna (52 percent) [64], Taylor and Todd (52 percent) [
> 65], and Mathieson (70 percent) [48]. The observed relatively low R2
> values may have in part resulted from limited influence from perceived
> ease of use. However, the results also suggested that other factors
> should be added to the research model. TAM appears to lack adequate
> specificity to explain and enunciate attitude and intention of
> physicians, which may partially have been affected by characteristics of

> health care and/or the nature of their profession.
>
>
> Limitations
>
>
> THIS EMPIRICAL INVESTIGATION OF TAM IN A PROFESSIONAL CONTEXT has
> several limitations. First, operationalization of the constructs
> included in the research model was basically drawn from prior TAM
> studies. Despite the reported validity and reliability, the measurements
> used in the study exhibited relatively low reliability values,
> particularly those for attitude and perceived ease of use. The observed
> limited reliability may suggest potential "nonapplicability" of the same
> instrument to a very different context or group of target users. This
> responds to and reinforces the importance of instrument reevaluation, as
> suggested by Straub [63].
>
> Second, responses to this study were voluntary and thus inevitably
> subject to self-selection biases. Conceivably, physicians who were
> interested in, had used, or were currently using telemedicine technology
> may have been more likely to respond. This might also explain why the
> response rate was not very high, even though support had been gained
> from the chiefs of service of participating clinical departments. The
> number of physicians interested in or currently using telemedicine
> technology may not be large, given the early technology adoption stage;
> but from the results of our nonresponse bias analysis it appears that
> the biases may not be significant.
>
> Third, the relatively low R2 values in our model compared with prior TAM
> studies suggest the potential limitations of TAM in this particular
> subject area and possible omission of factors important to individual
> technology acceptance in a professional context. A contingency approach
> that incorporates additional factors relevant to physicians' decisions
> to accept q technology might therefore be beneficial. Another promising
> approach is to use alternative intention-based theories, such as TPB, or
> to integrate TAM with such alternative theories to examine the physician
> technology acceptance issue. This study was intended as a starting point
> for investigations of technology acceptance by professionals using TAM
> as a theoretical model.
>
> Fourth, cultural differences could represent another limitation of the
> study. Conceivably, physicians from different cultures may exhibit
> considerable differences in attitude formation and technology
> assessment. For instance, physicians from a culture characterized by
> relatively high uncertainty avoidance [33] may perceive usefulness and
> user friendliness of telemedicine technology differently from those
> whose culture is more tolerant of uncertainty. Rosenzweig [58]
> challenges the presumption of conceptual equivalence across language and
> cultural barriers in management research. More work is required on this
> aspect.
>
>
> Conclusion
>

>
> THEORY TESTING HAS BECOME INCREASINGLY IMPORTANT FOR IS RESEARCH [29],
> and therefore examination or validation of existing findings of user
> technology acceptance is desirable, or even essential, particularly when
> different technologies, user populations, or organizational contexts are
> involved. This study represents research in examining the applicability
> of TAM to explaining physicians' acceptance of telemedicine technology
> within the health-care context. The model was evaluated using data
> collected from more than 400 physicians practicing in public tertiary
> hospitals in Hong Kong. Several implications can be drawn from the
> findings of the study.
>
> First, an important contribution to user technology acceptance research
> is the use of a preeminent intention-based model in a health-care
> context, which differs considerably in operational independence and
> individual autonomy from the business organizations ordinarily studied
> in previous research. On the one hand, we tested the "plausible"
> extension of the applicability of TAM and, on the other hand, we
> responded to a call for additional theory-testing efforts to validate
> research results accumulated from prior studies on IT
> acceptance/adoption.
>
> From a managerial standpoint, the findings of this study reveal that, in
> order to foster individual intentions to use a technology, it is
> important to encourage and cultivate a positive attitude toward using
> the technology. In this connection, positive perception of the
> technology's usefulness is crucial, whereas the technology's ease of use
> may not be equally important for professionals. One logical implication
> is that the management ora health-care organization, upon decision to
> adopt a telemedicine technology, should strongly emphasize devising
> effective means to communicate the clinical utility of the technology to
> member physicians. Information sessions and training on telemedicine
> need to focus primarily on how the technology can help improve the
> efficiency and effectiveness of physicians' patient care and service
> delivery rather than on the steps or procedures of actual use of the
> technology.
>
> Future research efforts are needed to address the limitations of this
> study. First, to expand the theoretical validity of the literature,
> reexamination of TAM with another professional population or a different
> IT application for a professional user group will be important. Ideally,
> this should be a series of studies in a variety of contexts including
> different technologies and professional user groups over a period of
> time. Longitudinal evidence obtained thereby might help us better
> understand the causality among variables and the applicability of TAM in
> the professional context.
>
> Second, additional assessments on the psychometric properties and
> measurement validity for the constructs included in TAM are also needed.
> Attitude and perceived ease of use are two specific constructs whose
> measurement validity requires reevaluation, as suggested by the
> reasonable but not superior Cronbach's alphas observed in the study.
>
> Third, the study did not test a full TAM. Actual technology use was not

> included in the research model, a constraint resulting from the early
> adoption stage of telemedicine technology. Continued studies that
> incorporate actual technology use into the research model would enable
> an increasingly complete examination of the applicability of TAM in
> explaining or predicting IT acceptance by professionals.
>
> Finally, future studies should also not be limited by the original TAM.
> An extended model may be increasingly appropriate for our research
> context--IT acceptance/adoption by professionals. Several recent IT
> acceptance/adoption studies have extended TAM to include additional or
> mediating variables such as self-efficacy [65, 67], prior usage and
> experience [66], objective usability [67], and user characteristics [
> 37]. Davis [22] also suggested additional factors to be included in the
> original TAM. Therefore, future studies should investigate the role of
> adding such variables to those originally used in the model. Exploring
> the applicability of alternative IT acceptance/adoption models may be
> essential as well. Candidate alternatives may include TPB [28] and
> Social Network Theory [56]. Such extended or integrated approaches may
> provide additional insights to our understanding of IT acceptance
> decision by professionals.
>
>
> NOTES
>
>
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> Special Administrative Region, China (Project No. HKUST6195/98H).
>
> (n1.) Segars and Grover [60] used confirmatory factor analysis with
> LISREL and identified potential weaknesses in the measures.
> Specifically, "perceived usefulness" was suggested to be split into two
> dimensions, "perceived usefulness" and "effectiveness." Chin and Todd [
> 15] questioned this interpretation and reexamined data from Adams et al.
> [1] together with data from a new study to show that the original
> single dimension of "perceived usefulness" probably was more accurate.
>
> (n2.) In general, primary care refers to general care (provided by
> general practitioners or physicians), secondary care involves medical
> specialties that require fellowship training, (board) certificate exam,
> and licensure requirements to practice. Tertiary care involves
> subspecialties, which are "specialties within a specialty." Examples of
> tertiary care include neurosurgery (within surgery) and neuroradiology
> (within radiology). Thus, hospitals or care centers that offer tertiary
> care are often called tertiary hospitals or centers.
>
> (n3.) The Hong Kong Telemedicine Association was established in November
> 1996 by a group of health-care and IT professionals to promote
> awareness, understanding, and applications of telemedicine among
> health-care professionals and the general public in Hong Kong. The
> Hospital Authority, which was formally inaugurated in December 1990, is
> the supreme government organization that manages and coordinates all
> public health-care establishments in Hong Kong.
>

> (n4.) We used these techniques, rather than LISREL, because most readers
> are more familiar with the former than the latter.
>
>
> Table 1. Analysis of Nonresponse Biases
>
>
> Legend for Chart:
>
> A - Dimension/measure
> B - Early respondents (n = 203)
> C - Late respondents (n = 205)
> D - Significance

A	B	C	D
Perceived usefulness (PU)	3.12	3.05	p = 0.488
Perceived ease of use (PEOU)	3.24	3.18	p = 0.515
Attitude (ATT)	2.78	2.78	p = 0.928
Intention to use (ITU)	3.16	3.07	p = 0.366

> Table 2. Analysis of Measurement Reliability: Descriptive Statistics and
> Cronbach's Alphas
>
>
> Legend for Chart:
>
> B - Mean
> C - S.D.
> D - Cronbach's alpha

A	B	C	D
Perceived usefulness (PU)			0.89
PU1	3.43	1.36	
PU2	2.80	1.17	
PU3	3.07	1.31	
PU4	3.04	1.20	
PU5	3.30	1.22	
PU6	2.91	1.16	
Perceived ease of use (PEOU)			0.79
PEOU1	3.02	1.30	

> PEOU2 3.46 1.16
>
> PEOU3 3.18 1.12
>
> PEOU4 3.26 1.19
>
> PEOU5 3.10 1.60
>
> PEOU6 3.21 1.18
>
> Attitude (ATT) 0.69
>
> ATT1 2.82 1.03
>
> ATT2 2.96 1.16
>
> ATT3 2.59 1.15
>
> Intention to use (ITU) 0.86
>
> ITU1 2.71 1.06
>
> ITU2 3.47 1.28
>
> ITU3 3.23 1.41
>
> ITU4 2.98 1.26
>
> ITU5 3.07 1.11
>
> ITU6 3.23 1.26
>
> [*] See appendix for abbreviations in Tables 2-4.
>
> Table 3. Analysis of Intermeasurement Correlation
>
>
> Legend for Chart:
>
> B - PU1
> C - PU2
> D - PU3
> E - PU4
> F - PU5
> G - PU6
> H - PEOU1
> I - PEOU2
> J - PEOU3
> K - PEOU4
> L - PEOU5
> M - PEOU6
> N - ATT1
> O - ATT2
> P - ATT3

```
> Q - ITU1
> R - ITU2
> S - ITU3
> T - ITU4
> U - ITU5
> V - ITU6
>
> A       B     C     D     E     F     G
>         H     I     J     K     L     M
>         N     O     P     Q     R     S
>         T     U     V
>
> PU1       1.00
>
> PU2       0.48   1.00
>
> PU3       0.64   0.55   1.00
>
> PU4       0.50   0.71   0.60   1.00
>
> PU5       0.69   0.55   0.58   0.48   1.00
>
> PU6       0.52   0.69   0.53   0.63   0.55   1.00
>
> PEOU1     0.07   0.10   0.07   0.10   0.08   0.07
>         1.00
>
> PEOU2    -0.03   0.06  -0.01   0.03  -0.04   0.01
>         0.34   1.00
>
> PEOU3     0.08   0.05   0.04   0.03   0.07   0.05
>         0.35   0.42   1.00
>
> PEOU4    -0.02   0.05   0.07   0.05  -0.01   0.06
>         0.38   0.26   0.31   1.00
>
> PEOU5     0.03   0.03   0.08   0.10   0.02   0.00
>         0.54   0.29   0.29   0.38   1.00
>
> PEOU6     0.07   0.00   0.04   0.00   0.04   0.00
>         0.55   0.50   0.45   0.33   0.44   1.00
>
> ATT1      0.32   0.30   0.33   0.30   0.33   0.36
>         0.15  -0.01   0.06   0.13   0.08   0.11
>         1.00
>
> ATT2      0.24   0.35   0.21   0.34   0.24   0.34
>         0.11  -0.03   0.04   0.07   0.06   0.07
>         0.49   1.00
>
> ATT3      0.26   0.35   0.31   0.32   0.28   0.28
>         0.08  -0.02   0.06   0.00   0.03  -0.02
>         0.43   0.36   1.00
>
```

> ITU1 0.30 0.32 0.29 0.28 0.31 0.32
> 0.19 0.08 0.22 0.19 0.01 0.07
> 0.28 0.22 0.24 1.00
>
> ITU2 0.36 0.41 0.36 0.36 0.39 0.40
> 0.10 0.05 0.12 0.08 0.03 0.04
> 0.34 0.26 0.22 0.51 1.00
>
> ITU3 0.37 0.40 0.35 0.38 0.32 0.39
> 0.09 0.09 0.16 0.11 0.04 0.08
> 0.24 0.30 0.27 0.48 0.51 1.00
>
> ITU4 0.31 0.35 0.25 0.34 0.26 0.35
> 0.09 0.04 0.15 0.15 0.04 0.00
> 0.21 0.31 0.22 0.52 0.47 0.63
> 1.00
>
> ITU5 0.36 0.35 0.25 0.31 0.36 0.34
> 0.16 0.10 0.14 0.09 -0.03 0.07
> 0.21 0.27 0.20 0.48 0.52 0.36
> 0.43 1.00,
>
> ITU6 0.40 0.38 0.35 0.35 0.40 0.39
> 0.07 0.02 0.20 0.12 -0.05 0.07
> 0.27 0.23 0.33 0.50 0.62 0.54
> 0.50 0.47 1.00
>
> Table 4. Factor Analysis Results: Principle Component Extraction
>
>
> Legend for Chart:
>
> B - Component 1
> C - Component 2
> D - Component 3
> E - Component 4
>
> A B C D E
>
> Perceived usefulness (PO)
>
> PU1 0.76 0.25 0.01 0.07
>
> PU2 0.74 0.26 0.02 0.21
>
> PU3 0.79 0.16 0.03 0.11
>
> PU4 0.76 0.19 0.04 0.20
>
> PU5 0.77 0.23 -0.97x10-3 0.09
>
> PU6 0.72 0.26 -2.65x10-3 0.22
>
> Perceived ease of use (PEOU)

>
> PEOU1 0.06 0.03 0.76 0.15
>
> PEOU2 0.01 0.07 0.67 -0.18
>
> PEOU3 -0.01 0.24 0.64 -0.08
>
> PEOU4 -0.06 0.14 0.59 0.10
>
> PEOU5 0.07 -0.14 0.71 0.12
>
> PEOU6 0.03 -0.01 0.80 1.30x103
>
> **Attitude (ATT)**
>
> ATT1 0.23 0.15 0.09 0.75
>
> ATT2 0.15 0.20 0.03 0.76
>
> ATT3 0.23 0.17 -0.02 0.66
>
> Intention to use (ITU)
>
> ITU1 0.15 0.73 0.13 0.13
>
> ITU2 0.29 0.71 0.03 0.19
>
> ITU3 0.25 0.70 0.07 0.14
>
> ITU4 0.14 0.75 0.04 0.15
>
> ITU5 0.23 0.65 0.07 0.07
>
> ITU6 0.27 0.74 0.02 0.11
>
> Table 5. Analysis of Overall Model Goodness-of-Fit Using Common Fit
> Indexes
>
>
> Legend for Chart:
>
> A - Model goodness-of-fit indexes
> B - Recommended value
> C - Results obtained from the study
>
> A B C
>
> Chi-square/degree of freedom </= 3.0 2.80
>
> Goodness-of-fit index (CFI) >/= 0.90 0.89
>
> Adjusted goodness-of-fit index (AGFI) >/= 0.80 0.86
>
> Normalized fit index (NFI) >/= 0.90 0.86

>
> Nonnormalized fit index (NNFI) >/= 0.90 0.89
>
> Comparative fit index (CFI) >/= 0.90 0.91
>
> Root mean square residual (RMSR) </= 0.10 0.07
>
> DIAGRAM: Figure 1. Research Model
>
> DIAGRAM: Figure 2. Model Testing Results
>
>
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>
> APPENDIX: Measurement Items Used in the Study
>
>
> A B
>
> Perceived usefulness (PU)
>
> PU1: Using telemedicine can enable me to complete patient
> care more quickly.
>
> PU2: Using telemedicine CANNOT improve my patient care and
> management.
>
> PU3: Using telemedicine can increase my productivity in
> patient care.
>
> PU4: Using telemedicine CANNOT enhance my service
> effectiveness.
>
> PU5: Using telemedicine can make my patient care and
> management easier.
>
> PU6: I would find telemedicine technology NOT useful for my
> patient care and management.
>
> Perceived ease of use (PEOU)
>
> PEOU1: Learning to operate telemedicine technology would NOT be
> easy for me.
>
> PEOU2: I would find it easy to get telemedicine technology to
> do what I need to do in my patient care and management.
>
> PEOU3: My interaction with telemedicine technology would be
> clear and understandable.
>
> PEOU4: I find telemedicine technology INFLEXIBLE to interact
> with.
>
> PEOU5: It is NOT easy for me to become skillful in using

> telemedicine technology.
>
> PEOU6: I would find telemedicine technology easy to use.
>
> Attitude
>
> ATT1: Using telemedicine technology in patient care and
> management is a good idea.
>
> ATT2: Using telemedicine technology in patient care and
> management is UNPLEASANT.
>
> ATT3: Using telemedicine technology is beneficial to my
> patient care and management.
>
> Intention to use (ITU)
>
> ITU1: I intend to use telemedicine technology in my patient
> care and management when it becomes available in my
> department or hospital.
>
> ITU2: I intend to use telemedicine technology to provide
> health-care services to patients as often as needed.
>
> ITU3: I intend NOT to use telemedicine technology in my
> patient care and management routinely.
>
> ITU4: Whenever possible, I intend NOT to use telemedicine
> technology in my patient care and management.
>
> ITU5: To the extent possible, I would use telemedicine to do
> different things, clinical or nonclinical.
>
> ITU6: To the extent possible, I would use telemedicine in my
> patient care and management frequently.
>
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Section 7: Organization Learning and Success in e-Health

ICT SUPPORTED COOPERATIVE WORK

Health Care and the Concept of Learning Organizations

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INTRODUCTION

Many countries in the world are in a process of great historical change. The changes have been proposed to be larger than those of the industrial revolution. Information and communication technology (ICT) plays a fundamental role for the changes. The changes in the society are many and many sectors are changed by the technology. Some sectors have already seen great organizational changes, e.g. the bank sector. Other sectors are in early stage of the changes the future may bring. The health sector is an example. An essential trait of the industrial revolution was the mass production of goods. In the post-industrial society, the knowledge and information society, this is replaced by production of knowledge, information and services (1).

With a society changing rapidly citizens may lifelong be a part of learning processes. Learning will become important in the new society. There is talk about learning organizations (2,3) and even a learning society (4). The capital of organizations is not only financial, but also the human capital (5). It is possible to speak about a *learning system* within organizations. The

learning system may play a role not only for more formal job training and education, but also for distribution of knowledge and skills among employees, reengineering of production processes, and the quality of health care.

In health-care information has already become easily available to patients with the Internet. Many doctors have experienced patients coming to the visit with information found on the Internet (6). The situation is more demanding for the doctors' professional competence. Remote education is already an important part of telemedicine in Norway (7,8,9) and in other countries (10,11,12,13,14). When modern tele-communications make learning less dependent of place we may speak about *anywhere learning* (4). When what needs to be learnt and where change, we may also speak about *flexible learning*.

In Norway the organizations of health-care are widely dispersed, as the population is. This does not make the dissemination of knowledge neither easier nor less important. Dissemination of knowledge and experience may be a tool for improved patient care (15). Dissemination of knowledge does not only occur as a result of programmes for education, but communication in the work situation plays a role. Employees of health care may be participants in informal networks. In such networks some doctors may be especially influential and important for learning (16). Learning may occur on an individual basis, for work groups, organizations, and organizations in networks. In the study of IT and human factors organizational learning has a central role. The onion model of this book illustrates this, where organizational learning is found at the core of the onion (17). Working with telemedicine has been proposed to result in learning (18,19,20,21). Such possible connection between communication technology and learning in health-care is little investigated (20,22,23). In the present study four qualitative questions were asked to obtain information

about actual learning from telemedical work, consequences of this learning, what could be done to promote people's learning, and how participants had learnt to use the telemedical equipment.

METHODS

The present paper is a part of a larger study and the methods have been described previously (22,24,25,26,27,28,29). Sampling was done by first contacting a local hospital where telemedical work was being undertaken. Those directly involved in the telemedical work gave details of persons and organizations with which they had telemedical cooperation. These people were in turn asked to provide details of others working with telemedicine. All who were identified were contacted and asked to participate in a qualitative interview. The data were collected in the period from September 1998 to April 1999. The interviews were tape-recorded and the larger investigation consisted of 39hrs 20 min of recorded interviews. On the basis of transcripts all information considered to be of interest was coded and to ease the review (30) transferred to a statistical package, i.e. SPSS (SPSS Inc., Chicago, USA). In all, 960 elements of information were recorded; for the present paper, 67 were examined. These related to four questions within the interview concerning learning.

RESULTS

Two of the 32 contacted persons refused to be interviewed owing to lack of time, giving a response rate of 94%. The 30 respondents worked for 13 organizations (seven hospitals, four

municipalities, one county-owned health center and one private general practice), all located in the five northernmost of Norway's 19 counties. For each of the 30 respondents mapping was performed of whom they cooperated with. In total there were 28 telemedical networks, which were different by at least one respondent, and seven telemedical networks, which were totally separate, with no respondent in common. A summary of the responses to three of the four qualitative questions is given in Table 1.

The respondents' distribution on the four types of telemedical work and their experience with telemedicine was:

(1) 12 worked in psychiatry - three psychiatrists, one general practitioner (GP), three psychologists, four psychiatric nurses and one assistant nurse with training in psychiatry. They had worked with telemedicine for an average of 3.9 years and had performed an average of 41 such remote consultations;

(2) six worked in dermatology - three dermatologists and three GPs. They had worked with telemedicine for an average of 4.2 years and had performed an average of 638 such remote consultations;

(3) 10 worked in a frozen-section pathology service - four pathologists, three surgeons and three laboratory technicians. They had worked with telemedicine for an average of 4.3 years and had performed an average of 43 such remote consultations;

(4) two worked in otolaryngology - one otolaryngologist and one GP. They had worked with telemedicine for an average of 3.5 years and had performed an average of 450 such remote consultations.

The hypothesis of age differences in the answers was analyzed. The median age of the 30 respondents was 45.5 years, Q_1 quartile=42 years (25% of the respondents have a lower age

than the Q_1 value) and the Q_3 quartile = 52 years (25% have a higher age than the Q_3 value). The sample was split according to age in two ways. The answers of those above and below median age were compared. The answers for those below the Q_1 quartile and above the Q_3 quartile were compared. For both ways of splitting age differences in the answers to three of the qualitative questions were difficult to identify. For the question 'Have you started to perform tasks yourself which you previously were seeking assistance for?' age difference in the answers was suspected. Further analysis showed those who answered 'yes' to the question to have a mean age of 44.6 years and those who answered 'no' a mean age of 46.9 years, but this is not at statistically significant difference ($p<0.05$).

70% (n=21) of the respondents were men and 30% (n=9) women. The material was split according to sex, but there were no obvious sex differences in the answers to the four questions.

The hypothesis of the answers to be dependent on volume of use was analyzed. Median for the number of remote consultations was: telepsychiatry = 22.5, teledermatology = 525, telepathology frozen section service = 22.5. Quartiles for the number of remote consultations were: telepsychiatry Q_1=4.8 and Q3=72.5, teledermatology Q_1=169 and Q3=1125, telepathologic frozen-section service Q_1=20 and Q_3=65. With only two respondents in teleotolaryngology values for median and quartiles are not given. For all four types of use the sample was split in high and low volume of use. For telepsychiatry, teledermatology and telepathology the sample was split in two ways. The answers above and below median number of remote consultations were compared. The answers of those below the Q_1 quartile and above the Q_3 quartile were compared. For the different ways of splitting volume of use, there were no obvious differences in the answers.

The four qualitative questions on learning with answers

'Have you learnt anything new by using telemedicine? If yes what?'

Of the five respondents working in teledermatology who answered yes, all three GPs told they had learnt more dermatology. Two said they had learnt more about technology and one specialist told that: 'use of two different settings makes me reflect over the methods we use'.

All twelve working within telepsychiatry said that they had learnt something new. Seven told that they had learnt more psychiatry. Each of the following was mentioned by one respondent: Learn each time (e.g. from the psychiatrist how to ask and from different angles being represented), learn from the instruction, learnt that planning is important, learnt how to behave in front of a camera, and learnt more technology. Also within psychiatry one said that use of two different settings gives reflection over methods used. Each of the following factors were mentioned by one respondent: 'have learnt about cooperation with the patients, about measures concerning patients' social setting, and strengthening of self care', learnt from working in a group with other professionals, learnt from cooperating with the specialist in psychiatry, learnt from participating in remote education, and learnt from using telepsychiatry.

Within the telepathology frozen section service seven respondents were of the opinion that they had learnt something new. Three told that they had learnt about the frozen section service. Two said that they had learnt more about making sections for microscopy. Each of the following answers were given by one respondent: learnt more pathology, have got a repetition of pathology, 'in the start I learnt from cooperating with other professionals like engineers and

sociologists', gives a basis for reflection on what we stress in diagnostic work with less information in the images, and telepathology is a new way of diagnosing although it is quite similar.

The one in teleotolaryngology who answered the question with yes said that he had learnt more otolaryngology and technology.

'Have you started to perform tasks yourself which you previously were seeking assistance for?'

Within dermatology the three GPs answered that they now did more themselves within the discipline. One said that he now sent fewer patients to the hospital with a dermatology department.

Of the five respondents within psychiatry who answered the question with yes each of the following factors were mentioned by one respondent: 'I have got more difficult patients', 'I am frequently used in other connections too', 'only to be in control of the technology', and 'to a certain degree, but still leaves much over to the specialist'.

Within the telepathology frozen section service one surgeon at a local hospital said that they admitted fewer patients to the university hospital.

Within otolaryngology one respondent said only to a certain degree, but that he still left much over to the specialist.

One of those who answered the question with no told: 'No, but maybe I become more confident and dare to diagnose on my own'.

'Could anything be done in telemedical work to promote your own learning?'

Within dermatology two GPs answered that they could learn more by extending telemedicine to include also other areas of medicine. One GP was of the opinion that other GPs who referred patients to him for teledermatology could themselves participate in the studio, and that this would have better learning effects for them. One said that more is learnt about communication by working via a screen.

Within psychiatry two told that more teaching should occur by telematics, and two were of the opinion that they could learn more if the instruction was done by telematics. Two psychiatrists told that they could have learnt more by telemedicine meetings with specialized expertise. Two were of the opinion that there was a need to summarize and describe the experiences with telemedicine. One GP who worked within telepsychiatry found that he could learn more by extending the use to other medical fields. Each of the following factors were mentioned by one respondent: Bring along other therapist in the studio as observer, more frequent use leads to more learning, greater possibility for bringing in external competence, and more experience with telemedicine.

Within pathology two pathologists and one laboratory technician mentioned that they could learn more with more experience. One of the laboratory technicians would have liked to visit the department of pathology more for learning. One surgeon told that if the technology had been better they could have had more remote teaching. Another surgeon wanted the

pathologist to speak loud about what he saw during the telemedical sessions and that (the name of an experienced pathologist) gave a course. One of the pathologists would have liked to have telemedical discussion groups for pathologists.

'How did you learn to use the telemedical equipment?'

Nineteen told that when they were new to telemedicine they received instructions on how to use the equipment. Eight said that they received no education or organized education. Eight told they had access to a technician. Three had learnt by trial and error. Only two had attended a course. Each of the following was told by one respondent: had three hours with instruction during a few afternoons, have participated in the development of the equipment, and 'responsibility for the telemedicine equipment has been given to the responsible for the studio. Do not feel this to be our responsibility'.

Within the telepathologic frozen section service the three laboratory technicians had been trained at a department of pathology to prepare frozen sections for telepathology, and two had also learnt by visits from the department of pathology.

DISCUSSION

In previous publications the methodology used to obtain the empirical data has been presented and discussed in more detail, with issues like qualitative vs quantitative studies, sampling, bias, and the reporting of qualitative data (e.g. 29).

In a study of IT it was proposed that older employees might find changes in the work situation more difficult, view implementation of IT as a threat, have problems with the understanding of functions, manuals and IT terminology (31). Such findings may be related to a lower educational level of older employees (31). Many of the present users were of a quite mature age. A previous study showed increasing age to be significantly correlated with decreasing anxiety for using the telemedicine technology (24). In the present study age differences in the answers could not be found, but splitting of the sample gives small subgroups. In the present sample higher age is also associated with higher educational level (14 were specialists in medicine) and with more experience. In a study of IT it was proposed that women might find it easier to learn how to use IT (31). In the present study no sex differences in the answers could be identified, but splitting of the material into subgroups based on sex gives small sample sizes.

The average experience with telemedicine should be enough to answer the questions. The variability in telemedicine experience in the material is not necessarily negative. Also in the future users will use the technology to different degrees. Selection of the respondents with the highest and lowest number of remote consultations could not confirm them to answer in different ways to the qualitative questions. But such splitting of those working within the four disciplines results in very small subgroups. In the future a larger volume of use may influence the answers to such questions.

From empirical basis to learning organizations

The present organization of the health sector is the result of a historical process and medical technology is often assumed to have had a basic influence on organization. But it is important to be aware that technology and organization may interact and constitute a complex phenomenon. Organizational consequences of technology do not mean that a simple cause and effect relationship exists. It may be easy to see the organizational potential of the technical infrastructure, but organizations may behave according to their own logic's. To obtain information about real organizational consequences empirical research is necessary. For the present contribution empirical data represent the core.

A previous study showed that joint consultations outside of telemedicine might lead to substantial educational gains for participants (18). A disadvantage with such joint consultations is the need to travel for the joint consultation. Learning for the rest of the life is not the product of a health-care education. Renewal and further development of the knowledge are necessary. With four of five in the present study telling they had learnt something new, the main impression is that learning does occur in telemedicine. The limited time used on teleconsultations per week is of clear educational value. Such diffusion of knowledge contributes to learning in the organizations and may improve services offered to the patients. The result may also be fewer return visits to the GP after a joint consultation between GP and specialist (18). It is known that employees working with telemedicine may share their experiences with each other (25). The social capital (knowing one another) of the organizations may improve. The transfer of knowledge from one organization to another may give organizational learning creating a collective memory across organizational borders. Learning need not result in the performance of new tasks, but nonetheless a third of the respondents reported such effects. The learning potential of telemedicine had not been fully

realized, though: two-thirds of respondents indicated that something more could be done in the telemedical work to promote their own learning.

If similar learning is found for other applications of telemedicine the term learning organizations will be relevant for future health care. When health care organizations are connected by systems for ICT supported cooperative work, they also connect for ICT supported cooperative learning. The learning effect in itself may constitute an argument for implementing telemedicine, and in future the thinking concerning formation of organizational networks may even take into consideration the question of which network has the best learning effects. In such a situation telemedicine may influence organization, and organizational design considerations will be more focused on organizing around the electronic networks, and take other considerations less into account (32). In telemedicine an increased number of employees are exposed to other than own expertise, and patients in other situations than they traditionally meet them. It is thinkable that increased contact with specialized care will lead to faster and more widespread adoption of new diagnostic and treatment measures.

In future work organizations may become important arenas for learning and may have to focus on learning (Harman 1979). The many possible applications of telemedicine (34,35) may be implemented in one and the same health service, and distance education may play a greater role. Leaders may have to develop a leadership facilitating organizational learning. Management to promote the intellectual capital of the organization may include a management of relationships between employees to promote knowledge sharing and to develop a learning organization culture and infrastructure (36,37). In telemedicine learning may be an unplanned by-product, but in learning organizations the learning becomes a part of an organized effort. It has been proposed that a clearly hierarchic organization may represent a

hurdle for the flow of knowledge in organizations, and that this is often the case in health-care (2,5,38). The answer may be decentralization of functions, change in organizational structure to a less centralized form, and delegation (39). Use of multidisciplinary teams may also promote learning (38,40).

When telemedicine is more a failure than a success it becomes important to understand why. The explanation may be found in factors like organizational design, culture, and decentralization status (41). Development of local champions and support from top management may also be important (42). Organizations with learning cultures may be keener to adopt new things, including new technology (41). May be organizations should not just wait with the reconsideration of their organization to take care of learning effects from implemented technology, but reconsider their organization when a greater implementation of new technology is planned.

'Have you learnt anything new by using telemedicine? If yes what?'

Trial and error is a well-recognized way of learning, but in health care such learning may have severe consequences for the patients and result in malpractice (20,43). With telemedicine personnel in rural areas may learn from medical specialists directly without running especial risks. When 83% of the respondents tell they have learnt something new by working with telemedicine, this can be characterized as a high figure. Most frequently the respondents improve their knowledge of the specialties in which they are involved. They may also learn other things, e.g. about technology and cooperation. It has been proposed that remote consultations, with GPs and specialists as participants, may result in considerable learning (18). Questions to Scandinavian hospital leaders showed 59% to be of the opinion that telemedicine gives better education of GPs (44). It should be noticed that all GPs of the

present study told they had learnt something new. Learning effects for GPs is clearly confirmed. The GPs' professional isolation may be reduced (45), and a decentralized development of competence promoted. The one to one relationship in the teaching situation may be important for the clear result for learning (45). Specialist and GP form a coach and apprentice relationship to take care of the patient. Other categories of personnel also learn, e.g. nurses and psychologists. Even the specialists may learn when they work with telemedicine.

In the present study all GPs in teledermatology told they had learnt more dermatology. Learning by the GPs in teledermatology has also been proposed by others (19). Also for the specialists the new work situation may be interesting and one of the specialists said: 'use of two different settings makes me reflect over the methods we use'. In psychiatry the technology provides considerable potential for learning. Health services could take advantage of this to a greater degree. All those involved in telepsychiatry said that they had learnt something new. Some even told that they learnt something new every time they worked with telepsychiatry. Most of the ten respondents working within the telepathology frozen-section service were of the opinion that they had learnt something new, and even the specialists report of learning. Surgeons may be reminded of some aspects of cytopathology, and for the pathologist the new situation gives a basis for reflection on what to stress when there is less information in the images. The present paper gives information about learning for four types of use of telemedicine. If similar learning is found for other applications, expansion of telemedicine could result in considerable learning.

'Have you started to perform tasks yourself which you previously were seeking assistance for?'

In future a situation may be created where work organizations require employees to become more flexible and adaptable in the work with tasks. Informal, flexible work-systems have been proposed to become the dominating organizational form of the 21st century (46). The unit one person-one function (or specific set of functions) may constitute a basic building block for organizations. But such organization limits the flexibility and adaptability to new situations. An extension of employees' roles would make health-care organizations more flexible, e.g. to changes in demand. Not only changes in technology may play a role for learning, but also organizational factors. It is a common opinion among Scandinavian hospital leaders that telemedicine means that local doctors can perform a more precise diagnosing (44). Learning in telemedicine may give local participants the necessary knowledge to take decisions without consulting specialists. When two of three respondents in the present material did not report having an extended professional role, this suggests limits to learning from telemedical work. For the involved in the telepathology frozen-section service there may be less opportunity for an extension of professional roles. When the telepathology frozen- section service is excluded from the sample, 45% (9/20) reported having an extended role.

In the present study one of three GPs in teledermatology said that he sent fewer patients to the hospital dermatology department, and all GPs answered that they now did more themselves within the discipline. In a study of teledermatology it was proposed that learning benefits for GPs could result in an average reduction of referrals of 20% (21). Fewer referrals and own performance of tasks they previously were seeking assistance for are examples of consequences of learning. The learning leads to changes with clear importance for economic analysis of telemedicine. It has been proposed that GPs working with remote consultations

become semi-specialists (47). The specialists function as role models for how work within a specialty should be performed (47). If a semi-specialist is someone able to take care of 50% of the patients without referral to specialist, calling GPs semi-specialists may be going to far.

In Norway supply of psychiatric expertise is limited. Telepsychiatry may improve access to the limited resource. When personnel perform tasks they previously needed assistance for, the total capacity of a mental health service increases. Discharge of patients to their local community may improve quality of life (48). Follow-up may occur via telepsychiatry, and an extended role for local personnel would reduce the daily dependency on outside psychiatric expertise. Extended roles may also improve job satisfaction (24).

It has been proposed that teleotolaryngology will lead to a better quality of examination technique on the part of the GP, and that this will decrease demand for expert services (45). In the present study the GP performing otolaryngology work mainly continued with remote consultations, rather than taking care of the patients alone.

'Could anything be done in telemedical work to promote your own learning?'

The alternative to delivering the expertise by telemedicine could be to develop competence at local sites. The problem is that such training would cost more, and it takes time to develop competence. Economies of scale considerations may question such a way of proceeding. Demand at local sites may be too low to fully exploit the competence. In such situations using telemedicine can solve the problem.

The more informed patients, as a result of the Internet (6), are more demanding for the personnel's competence. In the remote consultation specialist and GP work in same time, with the same patient, have the same information about the patient, and there is only one teacher and student. For clinical learning this may be a good situation. The technology may contribute to a more seamless care and the personnel come in direct contact with more of the total episode of care. Two-thirds of respondents answered the question with yes. Telemedicine seems to represent a potential for learning not fully exploited. Learning could be promoted by extending the use of remote consultations to other areas. In addition to the four disciplines studied here a number of disciplines have actuality (34,35), like geriatrics, acute medicine, rehabilitation, surgery (e.g. guidance during surgery), gastroenterology (endoscopic examination) and ophthalmology. Extended use of the remote consultation may occur for example between primary care and hospitals, home health care and hospitals, nursing homes and hospitals, and local hospitals and university hospitals.

When all respondents within psychiatry tell they learn, exploiting this systematically should be considered. This can be done by including teleconsultations, with a remotely located mentor, in the ordinary education of personnel, organize the availability of specialized expertise from central locations, and by arranging telemeetings about treatment of patients. In psychiatry multidisciplinary teams may have a role to play (e.g. when patients are discharged from mental hospital to local community), but it may be difficult to find time for a common meeting for people from different organizations and locations. The technology makes it easier to arrange meetings for multidisciplinary teams and more such meetings may promote learning.

In general more distance education is wanted. With the technology lectures by leading experts, previously attended by few, can be made available for the many. Transfer of knowledge from one organization to another may lead to greater similarities in competence, ease communication between organizations and enhance quality. For quality assurance more participative, open and enhanced feedback of results may play a positive role, together with greater decentralization giving the professionals power to review and implement changes (41).

The cooperation between specialists and generalists may develop social ties and make them share some professional and cultural values. This could promote the cooperation and the learning further. Merging organizations, on the different sides of the networks, would give a common management possibility to influence the situation by strengthening the ties and similarities even further. When organizations cooperating by telemedicine are separate management may also want to develop stronger network relationships between the involved on both sides. Development of relationships can be done, for example by arranging common meetings of social and professional character. In future more could be required from health care organizations when it comes to developing network relationships.

Diffusion of technology is influenced by characteristics of the technology, organizations, communication, economics, and regulations (e.g. legislation, financing methods). For both sites to find time for each session of remote consultations some work may be required. In practice such extra work may represent a barrier for diffusion of remote consultations, and result in patients waiting longer for treatment. The alternative could be that a primary health care center and a specialist department decide, for each coming half-year, day and time for telemedicine sessions. Based on knowledge about consumption this could be for example one half day per week for dermatology patients.

'How did you learn to use the telemedical equipment?'

For Electronic Patient Records adequate skills for system users have been pointed out as important, and we find ideas about improving computer education for health personnel on a larger scale by the 'European Computer Driving Licence Health Supplement' (49). In the present material 90% told that they found the technology easy to use (24). This in spite of few having learnt to operate the equipment by attending a course. The finding may in part be explained by some having access to a technician. More extensive training seems unnecessary to work with the technology. Instructions in the start may be enough. The equipment can be switched on as the light is switched on. Calling a hospital can be done by pressing a button with the name of the hospital on. Still the belief that operation of the equipment is difficult may represent a barrier to its use, and it is possible that more information could overcome this perception and contribute to a more rapid expansion of telemedicine. The further expansion of telemedicine could also be promoted by economic incentives, such as a per consultation method of payment (50).

CONCLUSIONS

Learning by telemedicine more than lives up to expectations. Telemedicine work undoubtedly results in learning. More than four of five of the respondents tell that they have learnt something new by working with telemedicine. Most frequently the participants learn of the specialty in which they are involved. When two of three respondents said that more could be done in telemedical work to promote learning, this demonstrates the potential for learning by telemedicine. The remote consultation can be used in a higher number of disciplines and

between several levels of care. When all within psychiatry learn taking the full advantage of this, e.g. by including telepsychiatry in teaching programmes, should be considered. More remote education is wanted and could improve competence and quality. Lectures by leading experts could be made available for many irrespective of location.

All GPs learn, but so do also nurses, psychologists, other categories of personnel, and even medical specialists. The learning does not necessarily change behavior as two-thirds of the respondents cannot tell that the learning make them perform tasks they previously needed assistance for. It may look exaggerated to claim that GPs become semi-specialists by working with remote consultations. The volume of patients they take care of on their own is hardly that large.

To start working with telemedicine instructions in the start seem to be enough, and more extensive teaching programmes are not necessary.

In future, with more telemedicine, work organizations may become important arenas for learning, and leaders may have to focus on learning. The term learning organizations may become important. Learning organizations may be designed to promote learning in the organizations, to keep at pace with the rapid increase in medical knowledge, increased quality requirements, more demanding patients, and make technology implementation more successful. For health care organizations essential questions will be: What kind of learning is wanted? Which organizational measures can be taken to influence learning?

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Table 1 – Summary of answers to three of the qualitative questions (n=30)

	Yes		No	
	N	%	n	%
Have you learnt anything new by using telemedicine?	25	83	5	17
Have you started to perform tasks yourself which you previously were seeking assistance for?	10	33	20	67
Can anything be done in telemedical work which promotes your own learning? [a]	20	67	9	30

[a] One (3 %) did not know

Organizational Learning and Culture

in the Managerial Implementation of

Clinical e-Health Systems:

An International Perspective

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The Problem

Organizational culture is recognized as a key component of knowledge management and organizational learning.[1] However, organizational culture is significantly influenced by national culture.[2] Further, for organizational culture to function effectively as a managerial control mechanism, the organizational culture and the formal organizational structure must be harmoniously interrelated.[3] Thus, the structure and culture of an organization must be aligned with the demands and predispositions of the environment in which the organization operates;[4] noting that a significant aspect of that environment is the national culture in which the organization is embedded.[2]

Modern health care organizations are confronted with a steady stream of new clinical e-health technologies, many of which have significantly enhanced the quality of clinical practice. Some of these technologies have also offered the

potential of increasing access and/or reducing the overall societal costs of healthcare.[5&6] Yet, early evidence suggests great difficulty in implementing some of these new technological advances in the U.S.A. (Bangert and Doktor, 2000).[7]

Telemedicine is a good example of this challenge. Bashshur[5] discusses how the second generation of telemedicine has the requisite technology, but faces such uncertainties as lack of long-term sustainability plans, lack of mature programs that can be the basis of definitive cost-benefit analyses, and limited acceptance of telemedicine by health providers and health administrators.[5] Telemedicine was originally conceived as a two-way video conference between a primary care provider and patient at one end, and a specialist at the other end. It has evolved into a clinical information technology sub-system inclusive of multi-media email, web-based applications, and real-time consultation transfer of detailed clinical patient information that flows between health-care providers and often to/from patients. This development holds the potential for enhanced patient access to better health care, reduced total health care costs and, as a consequence of easy access to the most appropriate specialist expertise, higher overall quality of the health care delivered.[8] Despite the great promise of clinical e-health solutions, such as telemedicine, successful implementations with high utilization have been rare in the U.S.A.[9]

There are many reasons for poor implementation performance[10&11]: often legal barriers prevent telemedicine's use across political boundaries; the issue of

reimbursement to Health Care Providers (HCP) often presents a barrier to utilization; and sometimes the technology does not perform as promised. While these issues are real and relevant, they do not explain what we believe to be one of the primary causes of the problem: organizational dynamics.[12&13]

Most modern health care delivery organizations in the USA are conceived, designed and structured to promote effectiveness and efficiency of a bygone era -- a time when quality was assured by formal authoritarian control, iron-clad rules, and a one-best-way mentality. In some national cultures, such an organizational approach is still appropriate. However, we contend that in many national cultures around the globe, a successful adoption of an e-health strategy requires a more organic and less mechanistic organizational culture and structure. For health care organizations of such national cultures, a more organic form will better match the cultural and knowledge/learning predispositions of the organization's members. The acceptance of the highly disruptive technology by the members is fundamental to its successful adoption.

When the organizational culture and structure are in harmony with the predispositions and demands of the national culture within the organization's environment, then it is our contention that the organization is primed to be a fast learning organization.

All organizations learn. Some organizations learn more quickly than others. A key determinant in the speed with which an organization analyzes its environment and changes its behavior to be more adaptive to that environment (i.e. LEARNS) is its culture. With other things being equal, such learning depends upon the underlying harmony between the organization's national culture[1] on the one hand, and its organizational culture and structure, on the other. The greater this harmony, the speedier is the learning. The speedier the learning, the greater is the effectiveness of implementations of new technologies.

Health care systems need to adapt to changing environments, draw lessons from past success and failures, detect and correct errors of the past, anticipate and respond to impending uncertainty and realize images of a desirable future. There is a virtual consensus among leaders in health care as to the "learning imperative" and in the world of health care organizational practice; organizational learning has become an idea in good currency.[14]

But not all organizations, in health care or in other industries, learn at the same speed or in the same way. Different organizations have different learning styles.[14] Some organizations are best at adaptive learning (sometimes referred

[1] Multinational organizations exist in many cultures concomitantly. Some multinationals retain their parent national culture throughout. In these cases, it is the parent national culture which we refer to when speaking of national culture. Other multinationals encourage each subsidiary to embrace the national culture in which that subsidiary is embedded. In these cases, by national culture vis-à-vis organization structure and culture, we mean the national culture in which the subsidiary is embedded.

to as single-loop learning), i.e. changes made in reaction to changed environmental conditions. Other organizations have a learning style often referred to as proactive learning, i.e. organizational changes made in anticipation of a desired end state. That is, the organization has a systemic model of its interaction with the environment and a forecasting model of the environment's future behavior. Based upon these models, the organization generates actions designed to interact with the environment's future behavior in a manner to produce the organizationally desired end-state. Proactive learning is often referred to as double-loop learning[14] or generative learning.[15]

We contend that for organizations embedded in some national cultures, the most appropriate organizational culture and structure is that which achieves its speediest and most effective learning performance through an adaptive organizational learning style. In other organizations, embedded in different national cultures, the most harmonious organizational culture and structure need to promote proactive learning; and, although more complex than an adaptive organizational learning style, such a proactive organizational learning style is actually speedier and more effective for these organizations.

In what follows, we discuss certain dimensions of national culture which drive the development of organizational culture and structure that are most appropriate for an optimal organizational learning style. We focus on health care delivery organizations; we relate their organizational learning effectiveness to

their competency in implementing and utilizing new clinical e-health technologies.

We assert that cultural analyses have shown that what works in one culture may not be appropriate in another (Hofstede, 2001; Bangert and Doktor, 2000).[2] Specifically, we will discuss how the capacities of a successful health care delivery organization depend upon the values of the society it serves, and, accordingly, that one solution to the e-health implementation problem does not fit all situations.

Relationship To Other Articles In This Book

In the literature review which follows, the reader will notice many "layers of the onion" analyzed as separate literature. As noted in the preface of this book, the chapter demarcations are artificial categories there only to serve readers' cognitive habits of linear information processing,

Along those lines, this contribution best fits in our last chapter which is devoted to organizational learning and e-Health utilization. Nonetheless, there are strong interrelationships with many of the articles in preceding chapters. The layers of the onion are not independent and instead are integrally connected, each to all others; that connection is manifest in the pages which follow.

In this chapter of the book, the article by Aas discusses the significance of organizational learning to the utilization of telemedicine. He shows how telemedicine utilization interactively effects and enhances organizational learning in his study in Norway.

The Literature

Cross-Cultural Organization Literature

We find the work of Geert Hofstede[16, 2, 17,18] insightful when considering the organizational designs for successful e-health implementation. Hofstede has argued that organizational systems work best when their design is consistent with the underlying values and culture of the society in which they function.[17] In particular, Hofstede has pointed out that American management practices may not be appropriate or successful when implemented in societies with cultural values that differ from those held in the United States. Critics of Hofstede's work believe that he takes too simplistic a view of the multifaceted, complex dimensions which comprise the notion of culture. However, for our purposes, Hofstede's defined basic dimensions are exceedingly useful theoretical constructs.[2] Hofstede's five dimensions of cultural variability are: 1) power distance, 2) uncertainty avoidance, 3) individualism-collectivism, 4) masculinity-femininity, and 5) Confucian dynamism (long versus short-term orientation).[2] Each of these dimensions is rather complex; we refer the reader to Hofstede for a complete analysis.[2] However, it is the second basic dimension, uncertainty avoidance, which seems most relevant to our analysis of the relationship of

organizational design to organizational learning and, in turn, to successful e-health implementation.

Uncertainty avoidance refers to the extent to which people feel threatened by and avoid uncertain or unknown situations. Cultures with high uncertainty avoidance value predictability and stability. They create formal rules and believe hardily in their relevance. They prefer fixed structures and clear interpretations. They like things black and white, not gray. They dislike experimenting with unknown outcomes.

We maintain that societies high in uncertainty avoidance create environments that strongly favor mechanistic organization. They do so to achieve the organizational learning necessary for such changes as the successful implementation of disruptive technology – and we suggest that the obverse may be true for low uncertainty avoidance cultures.

Hofstede's measurement of national cultures reveals that such countries as Japan, France, and South Korea have high uncertainty avoidance.[2] Examples of middle level uncertainty avoiding national cultures are Italy and Taiwan. National cultures scoring low on uncertainty avoidance include Singapore, USA, and Great Britain. The complete ranking of countries is in Table 1.

- Place Table 1 here -

TABLE 1

Scores on Five Cultural, National Dimensions for 53 Countries or Regions (from Hofstede, 2001)

{PRIVATE } Country	Power Distance		Individualism/ Collectivism		Masculinity/ Femininity		Uncertainty Avoidance		Confucian Dynamism	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Argentina	49	18-19	46	31-32	56	33-34	86	39-44	-	-
Australia	36	13	90	52	61	38	51	17	31	9-10
Austria	11	1	55	36	79	52	70	29-30	-	-
Belgium	65	34	75	46	54	32	94	48-49	-	-
Brazil	69	40	38	27-28	49	27	76	32-33	65	18
Canada	39	15	80	49-50	52	30	48	12-13	23	4
Chile	63	29-30	23	16	28	8	86	39-44	-	-
Colombia	67	37	13	5	64	42-43	80	34	-	-
Costa Rica	35	10-12	15	8	21	5-6	86	39-44	-	-
Denmark	18	3	74	45	16	4	23	3	-	-
Ecuador	78	45-46	8	2	63	40-41	67	26	-	-
Finland	33	8	63	37	26	7	59	22-23	-	-
France	68	38-39	71	43-44	43	18-19	86	39-44	-	-
Germany,F.R.	35	10-12	67	39	66	44-45	65	25	31	9-10
Great Britain	35	10-12	89	51	66	44-45	35	6-7	25	5-6
Greece	60	26-27	35	24	57	35-36	112	53	-	-
Guatemala	95	51-52	6	1	37	11	101	51	-	-
Hong Kong	68	38-39	25	17	57	35-36	29	4-5	96	22
Indonesia	78	45-46	14	6-7	46	23-24	48	12-13	-	-
India	77	43-44	48	33	56	33-34	40	9	61	17
Iran	58	24-25	41	30	43	18-19	59	22-23	-	-
Ireland	28	5	70	42	68	46-47	35	6-7	-	-
Israel	13	2	54	35	47	25	81	35	-	-
Italy	50	20	76	47	70	49-50	75	31	-	-
Jamaica	45	17	39	29	68	46-47	13	2	-	-
Japan	54	21	46	31-32	95	53	92	47	80	20
Korea, Rep. of	60	26-27	18	11	39	13	85	37-38	75	19
Malaysia	104	53	26	18	50	28-29	36	8	-	-
Mexico	81	48-49	30	22	69	48	82	36	-	-
Netherlands	38	14	80	49-50	14	3	53	19	44	14
Norway	31	6-7	69	41	8	2	50	16	-	-
New Zealand	22	4	79	48	58	37	49	14-15	30	8
Pakistan	55	22	14	6-7	50	28-29	70	29-30	0	1
Panama	95	51-52	11	3	44	20	86	39-44	-	-
Peru	64	31-33	16	9	42	16-17	87	45	-	-
Philippines	94	50	32	23	64	42-43	44	10	19	3
Portugal	63	29-30	27	19-21	31	9	104	52	-	-
South Africa	49	18-19	65	38	63	40-41	49	14-15	-	-
Salvador	66	35-36	19	12	40	14	94	48-49	-	-
Singapore	74	41	20	13-15	48	26	8	1	48	15
Spain	57	23	51	34	42	16-17	86	39-44	-	-
Sweden	31	6-7	71	43-44	5	1	29	4-5	33	12
Switzerland	34	9	68	40	70	49-50	58	21	-	-
Taiwan	58	24-25	17	10	45	21-22	69	28	87	21
Thailand	64	31-33	20	13-15	34	10	64	24	56	16
Turkey	66	35-36	37	26	45	21-22	85	37-38	-	-
Uruguay	61	28	36	25	38	12	100	50	-	-
USA	40	16	91	53	62	39	46	11	29	7
Venezuela	81	48-49	12	4	73	51	76	32-33	-	-
Yugoslavia	76	42	27	19-21	21	5-6	88	46	-	-
Regions:										
East Africa	64	31-33	27	19-21	41	15	52	18	25	5-6
West Africa	77	43-44	20	13-15	46	23-24	54	20	16	2
Arab Countries	80	47	38	27-28	53	31	68	27	-	-
Bangladesh	-	-	-	-	-	-	-	-	40	13
China	-	-	-	-	-	-	-	-	118	23
Poland	-	-	-	-	-	-	-	-	32	11

Organizational Design Literature

The appropriate design of an organization depends upon many factors, the most salient of which are the strategic intent of the organization[19] and the environment in which the organization operates.[20,21,22,23]

The research literature on organizational design [24,25,26,27,28] considers both the structural elements of design and the cultural elements of design.[29,30] Of the structural dimensions formalization and centralization [24,31,28,32,33] stand out; of the cultural dimensions values, learning style, and strength [34,2] stand out.

Organizations with high formality are defined as having high division of labor[35,36], maintaining strict rules[37] and discouraging multiple job skills[37]. High centralization in organizational design exists where communication is controlled by strict vertical, individual command chains[38] and where communication about and participation in decision-making is discouraged[39]. Organizations with high formality and high centralization are often referred to as highly mechanistic in their structure.

Organizations with the obverse structural characteristics are said to be more organic in their structural design. A strong parallel exists on the cultural side of organizational design. Organizations with cultures that encourage participation, two-way communication and decentralize decision making are often characterized as being more organic. They are usually more open about making

mistakes, more encouraging of questioning and participation, highly supportive of testing new things, more willing to accept diversity, and tolerant of ambiguity.[34] Organizations that fall into the mechanistic category are closed to admitting mistakes, punish mistakes, avoid diversity, and are intolerant of ambiguity. Organizational form thus spans the spectrum from organic to mechanistic, with each organization falling somewhere between these two ideal types and having shades of both organic and mechanistic dimensions. The issue is one of relativity: is the organization generally more organic in its structural and cultural dimensions, or is it more mechanistic?

Technology Diffusion Literature

The research literature on technology diffusion in organizations in the USA has shown low correlation between centralization/formalization and the acceptance/adoption/implementation of technology[40]. Meyer and Goes[41] studied the technology diffusion process in 25 hospitals as those organizations were deciding to adopt medical innovations such as CAT scanners, ultra sonic imaging, laser surgery, and fiber optic endoscopy. They found only 10% of the variance in adoption success attributable to organization structural variables; they found 40% of the variance, however, attributable to organizational cultural variables such as attitudes, perceptions and especially the climate for innovation created by the organizations' leadership.

Organizations most likely to adopt new technical innovations were those with cultures that encouraged their members to try new approaches to meet environmental demands. Van de Ven and Rogers[42] point out that an adoption of technology often falters because the innovation fails to align with the organization's perceived problem, or the expected consequences are perceived by the organization's members as more negative than positive.

Research on computer-related technical innovations in organizations points to the perceived "uncertainty" created by the innovation as a source of resistance to adoption of the technology[43]. The concept termed 'uncertainty' by these researchers is akin to the dimension of uncertainty avoidance[2].

Resistance to Change Literature

Just as technology diffusion literature enriches our understanding of the role of organization design in the implementation problem, so too the long-in-history literature on resistance to change and change-management adds insight [44]. A primary tenet of this school of thinking is the concept of attitude change. William Bridges[45] purports that attitude change requires a three-phase phenomena: 1) unfreezing (ending), 2) transitioning (neutrality), and 3) refreezing (new beginning). Organizational design frames the capacity for attitude change: most resistance to change in organizations is founded in rational decisions that are based on currently held attitudes of members relative

to their position in the organization and the consequences of the change from the point of view of that position.

In his book *Leading Change*, J.P. Kotter[46] asserts that technological change needs a visionary leader who is capable of sharing the vision of using the new technology. The leader must also motivate its use and visibly reward those who first begin to adopt and use the new technology. Of greatest importance, according to Kotter[46], the new technology must become part and parcel of the organization's culture -- as integral to the way in which that organization does business.

Organizational Learning Literature

Many scholars attribute the original work on organizational learning to the work of Cyert and March[47], Bateson (1972)[48] and Argyris and Schon[49]. Schein[50] points out that there has been so many contributions to the organizational learning literature from so many different fields, such that there now exists considerable confusion with regard to a consensus definition of the term "organizational learning". Most scholars do agree, however, that organizational learning speaks to non-transient changes in an organization's behavior as a consequence of its interaction with the environment. There have been many scholars who have explored the concept of style in the study of organizational learning (Argyris and Schon, 1996; Yeung, Ulrich, Nason and Von Glinow, 1998).[14,51] Despite the many different classifications of organizational style present in the literature, it is

Argyris and Schon's (1978) original dichotomy of single-loop versus double-loop learning style which has passed the test of time and is most often researched and alluded to by most scholars of organizational learning. This dichotomy has also been reframed: lower level versus higher level learning,[52] tactical versus strategic learning (Dodgson, 1991)[53] and adaptive versus generative learning[13].

The literature on organizational learning styles does not agree on the "best style." Some scholars criticize single-loop learning (Chaston, Budger and Sadler-Smith, 2000)[54]. Aas (1996)[55] points out that there is no one best style for an organization to learn. It all depends on the environment in which the organization is embedded. Fiol and Lyles[52] point to the advantages of single-loop learning in stable, more predicable environments. Senge (1990)[56] indicates that in uncertain environments, characterized by discontinuous change, double-loop learning may be the most appropriate organizational learning style.

The concept of organizational learning[34], at an aggregate level, mirrors the dynamics of the resistance to change literature. Organizations with high learning cultures are keen to adopt new things, welcome diversity, and embrace change. At the aggregate level, a learning culture stimulates the unfreezing to refreezing phases noted in the resistance to change literature. Both organizational learning literature and change management literature, from different vantage points, reach similar conclusions, yet at different levels of aggregation.

DeLong and Fahey[1] argue that culture shapes the assumptions that are relevant to the importance of knowledge. DeLong and Fahey (op. cit.) further state that culture embodies all the unspoken norms or rules about how knowledge is to be distributed between the organization and the individuals in it. Culture dictates what knowledge belongs to the organization and what knowledge remains in the control of individuals and subunits.

Technology Acceptance Model Literature

The Technology Acceptance Model (TAM) was developed by Davis, et. al. [57] to understand the relationship between attitudes, intentions and behavior of potential IT users. Since its development, over 400 journal citations of the original Davis, et. al.[57] article have been noted by the Social Science Citation Index. Therefore, the TAM is a well researched hypothetical construct. Most, but not all, TAM research indicated that if the potential user believes that the IT system will help her accomplish her task, and to a lesser extent will be easy to use, then the potential user will self-report that she will use the IT system.

However, Lucas and Spitler[58] have shown that in real field settings, organizational variables, such as cultural norms and the nature of the job, were far more important in predicting the use of technology than the potential user's perception of likely usefulness or ease of use. Further, Hu et. al.[59] report that the TAM did not predict the use of telemedicine by physicians. Hu et. al [59] suggest that cultural and professional/organization variables may be more

explanatory of telemedicine use than perceived usefulness or perceived ease of use as measured by TAM.

Barki and Hartwick[60] suggested that the higher the degree of the user's perceived participation in the development of the system, the more likely s/he would use the system. They posited that user involvement entails the execution of a set of activities as well as the psychological state of the user.

The Theoretical Construct

In our new information technology-rich environment, it is appropriate to raise questions about organizational design in health care delivery organizations. In the late 1960's, C. Perrow [61], a highly respected sociologist, foreshadowed the issue by suggesting that in U.S. human service organizations, where new technologies are manifest, the organizational structure needs to have: less bureaucratic – less programming of tasks, more moderate in rules and regulations, fewer levels in the hierarchy, greater coordination by feedback, greater decentralization in decision making and a tendency to employ more highly trained professionals. Perrow's ideas of the late '60's and early 70's are, perhaps, even more relevant today in the USA.

Most major health care delivery organizations in the USA have not experienced an organizational design renaissance. Many of today's health care delivery organizations were designed to insure quality of care at reasonable costs. Their

designs were relevant to the pre-information technology age in which they were conceived in terms of level of centralization and authoritarian organizational culture. With some exceptions, most organization design modifications consist of small changes at the edges of the organization. The central tenet of U.S. organizational design in most health care delivery organizations remains: quality results from clear rules, high formalization, high authority and intolerance for ambiguity.

Yet research on implementation of technology in organizations, in general, points to the need to match the characteristics of the technology with the characteristics of the users rather than attempt to change the attitudes, mental models, alliances, or culture of the users[62,63]. This is most likely true in health care delivery organizations as well[59]. We extend the agrument to the organizations as well as the individuals in the organizations. In the U.S.A. and Great Britain and elsewhere, we argue, health care organizations, which have the utilization of e-health technologies as a strategic intent, need to re-address their organizational designs.

Distinctly, the concern for quality need not be sacrificed in an effort to redesign a more organic system. Anglo-American Quality Assurance research and thinking in modern health care organization research (Brook, et. al, 1985; Williamson, 1988; Shortell, 1992)[64,65,66] call for greater decentralization so that professionals responsible for care have the power to review and implement necessary

changes. This QA research also argues for more participative open and enhanced organizational feedback of results.[67]

The contemporary cultural context in the U.S.A. and Great Britain is one of low uncertainty avoidance, as shown to be an evolving truth over the last half century, and perhaps longer[2]. In such a cultural environment, new information technologies which may require changes in the normal routine of health care delivery are best utilized by organizations which are, we argue, more organic and more often employ double-loop learning. In South Korea and France, cultural environments characterized as high uncertainty avoidance[2], the organization of choice for implementation of e-health technologies should be a more mechanistic organization, more likely utilizing single-loop learning.

Why is this so? It is so because organizations wanting to effectively learn to utilize the new clinical e-technologies, must adapt to learning styles which are harmonious with their cultures and structures, and with the national culture embedded within the organization's environment.

In national cultures characterized with high uncertainty avoidance, single loop learning styles often afford speedier organizational learning. This is so as a consequence of high uncertainty avoidance going hand-in-hand with abhorrence of turbulence, lack of predictability and dislike for experimentation. In such cultural milieu, a single-loop learning style is far less threatening than the more

proactive double-loop learning style. Single-loop takes change one predicable step at a time. Double-loop concurrently seeks to anticipate change in the environment and match change in the organization, so as to achieve a desired end state which is the consequence of the interaction of the two simultaneous change processes. Thus, double-loop learning is far more ambiguous, interactive and complex. High uncertainty avoiding national cultures are more comfortable with more predictable organizational learning of the single-loop style.

Further, organizational structure and culture determine the amount and richness of information provided to its membership [68]. Mechanistic structure and culture restrict the flow of information down the organization. This, in turn, makes double-loop learning more difficult. Double-loop learning requires full and rich information to formulate accurate forecasting models of both environmental future actions and the resultant end-state of the interaction of those environmental future actions with the organization's actions. Therefore, double-loop learning is handicapped by the limited information flow found in mechanistic organizations. However, in organic organizations, information richness is encouraged and as such; double-loop learning proves to be more effective.

Thus, single-loop organizational learning styles are far more comfortable for organizations embedded in high uncertainty avoiding cultures. This does not mean that double-loop learning is precluded in this cultural context. It does occur. However, single-loop learning is the preferred "modes-operandi"; it is

likely to occur more often. When single-loop learning occurs in high uncertainty avoiding cultures, it is more accepted and less resisted by the organization's membership. As a consequence, with other things being equal, single loop learning, in general, is speedier and more effective than double-loop learning in high uncertainty avoiding cultures. This condition is greatly reinforced when the organization has a culture and structure which are mechanistic rather than organic.

An interesting organizational opportunity arises when three conditions occur:

- ❑ a mechanistic organizational culture and structure exists,
- ❑ a single-loop organizational learning style predominates, and
- ❑ the organization is embedded in a high uncertainty avoiding culture.

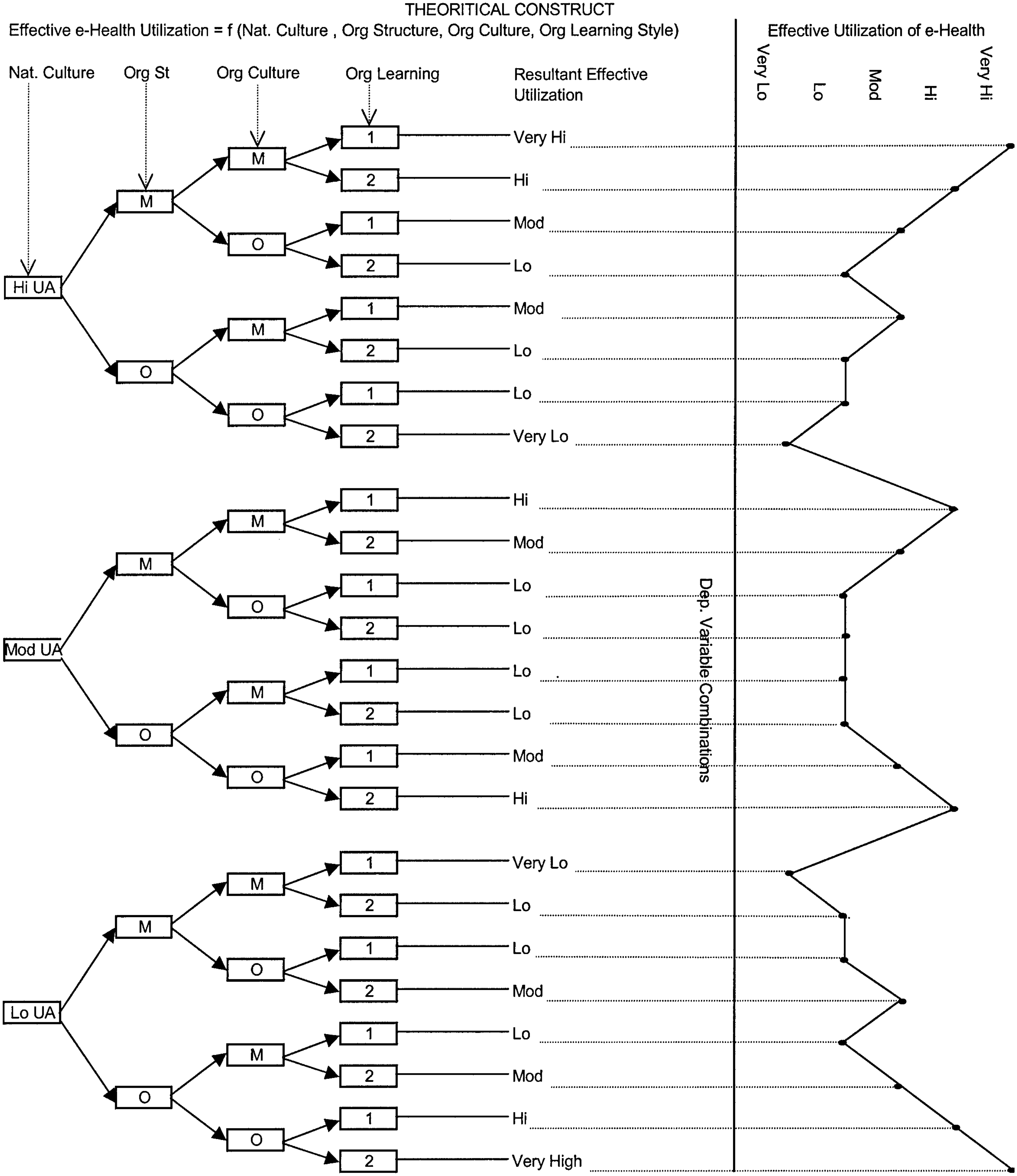
That organization is then able to buffer its membership from the anxiety of anticipated, unpredictable change that is potentially concomitant with all learning, and thereby fosters less resistance to speedier and more effective learning.

Figure 1 below displays the theoretical relationship of the independent variables of national culture, organizational structure, organizational culture and organizational learning style upon the resultant speed and effectiveness of e-Health utilization, all other variables held constant.

- Place Figure 1 here -

THEORITICAL CONSTRUCT

Effective e-Health Utilization = f (Nat. Culture , Org Structure, Org Culture, Org Learning Style)



Key
UA = Uncertainty Avoidance
M = Mechanistic Structure and Culture
0 = Organic Structure and Culture
1 = Single-Loop learning
2 = double-loop learning

Thus, the speediest and most effective e-Health utilization in high uncertainty avoiding cultures is seen to arise with mechanistic organizational structures and culture coupled with single-loop organizational learning styles. Similar theoretical constructs are altered for moderate and low uncertainty avoiding national cultural environments.

All that was said for single-loop learning and double-loop learning in organizations embedded in high uncertainty avoiding national cultures is the opposite for organizations embedded in low uncertainty avoiding cultures. Here too, organizations learn with both learning styles: single-loop and double-loop. But, the nature of the cultural values of the membership of such organizations favors double-loop learning. Pro-action and the experimentation associated with pro-action attract such organizational membership toward double-loop learning. The opportunity to concomitantly modify the environment while changing the organization, such that both changes result in a desired end state, is the attractive "modes operandi" in the low uncertainty avoiding culture.

When coupled with organic organizational cultures and structures, double-loop learning is better received, speedier and more effective than single-loop learning for organizations embedded in low uncertainty avoiding cultures. This still allows

for some circumstances in which organizations may choose to employ single-loop learning. It is not an all or nothing, on/off situation; it is a continuum along which diverse organizations are positioned. Some predominantly choose single-loop; others choose double-loop learning styles.

We postulate that in high uncertainty avoiding cultures, healthcare delivery organizations which choose mechanistic organization cultures and structures, and predominantly employ single-loop learning, will be more effective at implementing and utilizing clinical e-health technologies. The obverse is hypothesized to be true for health care delivery organizations embedded in low uncertainty avoiding national cultures. Figure 1 is an attempt to summarize these theoretical constructs pictorially.

Summary of the Results of a Small Pilot Study:

Our method involved interacting with, interviewing, and seeking data on e-health utilization success from health care delivery organizations in high uncertainty avoiding national cultures (France, South Korea) and in low uncertainty avoiding national cultures (USA, Great Britain), as well as to collect similar information in moderate uncertainty avoiding national cultures (Italy). The results of these case studies are published in detail elsewhere[69]. What follows is a brief narrative summary of our findings.

It was not possible for the authors to test the validity of all the theoretical constructs depicted in Figure 1. Rather, it was our choice to conduct a limited number of case studies in health care delivery organizations in each of the these categories of national culture (low, moderate and high Uncertainty Avoidance). This was done as a pilot exploration of the reasonableness of the theoretical constructs of Figure 1.

In France, (high Uncertainty Avoidance) three health care delivery organizations were studied. Full results of this study are available elsewhere[69]. We investigated two organizations in the major metropolitan hub and a third in a provincial capital. The first two organizations used multiple modes of telemedicine (both real-time and store and forward) effectively. We conducted interviews in and observed these organizations. The collected data pointed toward a mechanistic organizational structure and culture in place. Similar findings were obtained for the provincial health care delivery organization, through observation; interview data indicated that the telemedicine services, while effective, were not as efficient as those of the metropolitan health care delivery organization.

In South Korea (high Uncertainty Avoidance) we studied one health care delivery organization. This was a central urban, health care delivery organization with a constellation of twelve satellite, affiliate, smaller health-care delivery organizations. No direct observations were made, but interviews about and

demonstrations with Korean telemedicine system were undertaken. The organization proved to have a highly mechanistic organizational structure and culture; it was seen to be both effective and efficient in its utilization of interactive telemedicine, both for clinical decision making and for patient education[69].

In Italy (moderate Uncertainty Avoidance), we observed and conducted interviews in two urban health care delivery organizations. One was classified by interview data as slightly mechanistic in structure and culture; the second was slightly organic in structure and culture[69]. Both organizations advertised extensive use of telemedicine. Observation and interviews yielded marginal evidence of the actual utilization of telemedicine. At best, utilization could be rated as moderate to low.

In the USA (low Uncertainty Avoidance.) one health care delivery organization was observed and interviews conducted. It was in an urban center of Hawaii with multiple telemedicine links throughout the Pacific and Asia, as well as throughout the continental USA. Interviews and observational data identified its organizational structure and culture as mechanistic. Review of its telemedicine utilization results yielded very poor scores. Extremely large expenditures on infrastructure and staff resulted in little or almost no telemedicine utilization[69].

In G.B. (low Uncertainty Avoidance), we observed and conducted interviews in two health care delivery organizations: one was a large health care delivery organization in the major metropolitan hub; the other was a smaller health care delivery organization in a rural suburb of a large metropolis. In both organizations we found rather organic structures and cultures. Both were effective in implementing real time telemedicine. The case for store and forward telemedicine was mixed. While we found high effectiveness of utilization of telemedicine, the frequencies of utilization of all forms of telemedicine at both sites was moderate at best[69].

Concluding Discussion

The data of our qualitative research studies of health care delivery organizations in five countries cannot be said to confirm the theoretical constructs of Figure 1. However, they do not disprove these constructs and, in fact, our findings can be seen as a pilot study which support the general theory developed in this article.

Our major goal was to offer a theoretical argument for the need for health care delivery systems to consider an organizational renaissance. In an environment made turbulent by advances in technology, an organization's dynamics need to match the cultural predilection of its membership if the organization is to be effective and efficient in its implementation and utilization of the new technologies.

Only through a harmonious match of organizational structure and culture to membership national culture predilections can effective and efficient organizational learning emerge. And it is only through organizational learning that new technologies can be effectively utilized.

The cultural context in the U.S.A. and Great Britain is one of low uncertainty avoidance. In that cultural environment, new information technologies which may require changes in the normal routine of health care delivery are best utilized by organizations which are, we argue, most organic. In South Korea and France, a cultural environment characterized as high uncertainty avoidance, the organization of choice for implementation of e-health technologies appears to be a more mechanistic organization.

Nonetheless, it must be emphasized that these suggestions are relative. The divide between mechanistic and organic organizational design is not black and white, but rather gray and foggy. Our argument is only to ask executives and researchers in e-health to look at the bureaucratic structure of their organizations; to examine the level of formality and centralization and authoritarian culture and to ask: Is this the appropriate match for the people in our organization whom we depend upon to use new e-health technologies?

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Organizational Learning, Diffusion of Innovation, and International Collaboration in Telemedicine

David F. Robinson, Grant T. Savage, and Kim Sydow Campbell

The authors analyze competing forces affecting the diffusion of telemedicine practices across organizations, potential learning effects from telemedicine practice, and their implications for the development of telemedicine-based networks. They also speculate on the learning, diffusion, and institutional effects that telemedical collaboration may trigger; five sets of propositions are advanced to explain these effects.

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Telemedicine can be broadly described as a bundle of technologies designed to deliver health care services where the patient and the health professional are separated by physical distance. In North America, early diffusion of telemedicine has been largely shaped by government push efforts in the U.S. and Canada. On the one hand, within Canada's publicly financed system of health care, government incentives have hastened a broad diffusion of telemedicine.[1] On the other hand, within the mixed-market system of the U.S., government incentives such as grants and contracts have led to the limited diffusion of telemedicine programs to a relatively restricted number of health care settings such as prisons, rural areas, and university medical centers.[2] Hence, U.S. government funding of telemedicine projects has pushed this technology's use with underserved or difficult-to-serve populations.

However, the conditions related to the adoption of telemedicine appear to be changing as the technology matures and the related institutional systems adapt to make its use more effective. For example, reimbursement has become more accessible[3] and technology has improved with the availability of more bandwidth for transmission of data.[4] In addition, telemedicine software programs and equipment have become more varied[5] and much less expensive than early systems.[6] These changes have reduced some of the reasons cited for nonadoption of telemedicine as a medical delivery strategy for many organizations.[7,8]

The main purpose of this article then is to explore how the diffusion of telemedicine will change as government sponsored "push" efforts are joined or replaced by market forces and even more efficient and effective technology. By understanding the potential patterns of relationships that may form between health care organizations, administrators will be bet-

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ter able to identify potential telemedicine partners, predict competitors' telemedicine collaboration activity, and focus resources on the telemedicine relationships most likely to meet their organizations' goals. Regulators will also benefit by understanding how future diffusion patterns of telemedicine may differ from past patterns induced mainly by government funding. This knowledge will enable the regulators to sharpen the focus of government incentives, deploying them where most needed to achieve social goals that might not be achieved without incentives, and minimizing the use of incentives in areas that will likely develop without intervention. Understanding likely changes in organizations that may result from telemedicine interaction will help administrators and physicians see potential implications of collaboration earlier making the effects of telemedicine partnerships on organizations more predictable. Better predictability will help in the preparation of the organization to minimize the negative effects of collaboration and maximize possible knowledge gains and improve service delivery using telemedicine collaboration.

In the following sections of this article we present how organizational learning, diffusion of innovation, and competitive forces will influence the adoption of telemedicine as a health care delivery technology.

TECHNOLOGY, DIFFUSION, AND KNOWLEDGE

Prior research on telemedicine has emphasized four fundamental themes: (1) the clinical effectiveness and satisfaction with telemedicine; (2) the various technical means of delivering telemedicine; (3) cost comparisons of telemedicine versus other forms of medical delivery; and (4) the impact of telemedicine on knowledge and learning.[9-14]

The latter theme is the least developed, but shows great promise for organizational researchers. For example, research on telemedicine as a teaching tool has documented considerable interest and some success in improving learning.[15-19] Studies report learning taking place on the part of the medical personnel assisting in the delivery of treatment under the remote direction of a physician through telemedicine technology.[16,20] Moreover, tele-education and teleconsultation in surgical education has been shown to improve diagnostic and surgical skills.[18,21] In this article, we explore how competing forces affect the diffusion of telemedicine practices across organizations, how learning may induce adoption of telemedicine and initiate change in the affected organizations, and the implications for telehealth-based networks among organizations operating in separate national health care systems.

Learning and Telemedicine

From a learning perspective, telemedicine can be characterized as an intense data collection and analysis opportunity that can enable close observation of medical procedures and facilitate the diffusion of very intensive learning experiences. This is particularly interesting given the difficulties associated with trial and error learning in settings such as health care. Error can often mean injury or death. In these circumstances, learning from a few cases can be greatly enhanced by the intensive study of each occurrence.[22] While some research has already shown that telemedicine provides individuals a platform for learning specific medical techniques,[23,24] telemedicine may also provide the organizations involved with additional opportunities for intense information gathering and related learning.[25,26]

The desire to learn from relatively rare events and the ability of telemedicine technology to capture those events in great detail that can be accessed from a remote location may serve to induce some organizations to form telemedicine partnerships or networks for learning purposes. If these rare learning experiences and rich data accumulate over time, they may serve to allow intense learning from telemedical interventions. These experiences can lead to the creation of unique knowledge and the formation of unanticipated relationships between health care institutions in different countries. Access to unique knowledge can form the basis for sustainable competitive advantages in many industries and may also be a motivation for health care organizations to adopt telemedicine.[27]

Organizations innovate in many ways but not all of those innovations spread to other related organizations. Knowledge is often "sticky" or localized and innovations are not always understood or visible.[28] For example, an innovation in a fast food chain spread rapidly when a regional manager saw the innovation and then brought it to the attention of others in the chain.[29] Those other restaurants saw the relative advantage of the innovation over current practices and adopted the new procedure, incorporating it in its training program and standard operating procedures. A similar innovation spread only to other local chain locations even though it offered relative advantage over current

practices. It did not spread because no change agent or champion provided the effort needed to make the innovation visible and explain its advantage to potential adopters.[29] In health care there has been speculation that integrated networks of health organizations will lead to more widespread adoption of administrative and operational innovations.[30] Telemedicine has the characteristics of both an administrative and a technological innovation that literally links two different organizations or sites, thereby creating a very focused network via electronic communication. Organizations have to expend considerable effort to establish such a network but the network also encourages the transfer of knowledge.

Diffusion Processes

The diffusion process by which new technology is adopted by organizations is influenced by characteristics of the technology itself, organizational characteristics, communication, and contextual factors such as regulations and economics.[28,31,32] Rogers' studies of how quickly a new technology is adopted reveal five characteristics of an innovation that affect its diffusion. These characteristics include the innovation's relative advantage, its compatibility with existing technology, its complexity, the ability to try the innovation, and the opportunity to effectively observe the innovation.[28] Relative advantage is defined by Rogers as "the degree to which an innovation is perceived as being better than the idea it supersedes."[28(p. 212)] The nature of the invention and the characteristics of potential adopters affect the perception of the advantage the innovation offers and its value.[28]

Just as innovative technology may have different characteristics, so also do the organizations that adopt that technology. Early adopters of a new technology tend to be past innovators that have a relatively high social and economic status in the community. Early adopters also appear to have more cosmopolitan attitudes with larger numbers of social ties to outsiders than do later adopters. Later adopters tend to be rational and somewhat skeptical of innovations. They want to see evidence of the effectiveness of the innovation before they adopt it. Some late adoption appears to occur due to a lack of resources making late adopters more careful with the resources they have and less willing to risk them until the innovation is proven effective.[28]

Innovations diffuse into the environment partly due to forces that "push" or encourage others to adopt a new technology. Push efforts help communicate the relative advantage of the invention and if combined with financial incentives may affect the level of relative advantage by offsetting the initial cost of acquiring the innovation. Change agents often engage in push efforts targeting potential early adopters to demonstrate the effectiveness of the innovation. During the 1940s and 1950s, push efforts were a common practice for the U.S. agriculture extension services agents trying to persuade farmers to adopt better farming practices and improved varieties of hybrid corn and other crops.[33,34] These early studies led to the explicit study of the process now called the diffusion of innovations.[28]

However, many innovations also spread due to a "pull" or demand for them in the marketplace. External demand for innovations is a function of the utility of a new technology for solving organizational problems or adding value to an organization.[32] That value contributes to the success of the organization. The demand for telemedicine capability has been shaped in part by restrictions on reimbursement for telemedicine consultations.[35,36] Where reimbursement is reasonable, as is the case with teleradiology, telemedicine applications have flourished in the U.S.[37] For the most part, however, low levels of reimbursement in the U.S. have left telemedicine unable to deliver value for many medical applications,[7] and unable to establish a relative advantage in an economic sense. Consequently, government-based "push" programs to address specific societal needs, such as providing adequate care in sparsely populated rural areas, have initiated most of the demand for telemedicine in the U.S.[36,38]

Initial acquisition of telemedicine technology may be a simple process facilitated by "change agents" typically known as commercial sales representatives. Change agents function to raise the adopting organizations' awareness of the advantages of an innovation and assist in the assimilation of the innovation into existing operational routines or the design of new routines.[28] Once telemedicine technology is acquired, the organizations must establish their procedural protocols for managing the contacts between the organizations as well as for performing medical procedures.

Telemedicine collaboration between two independent organizations requires coordination of both the technology that transmits the data and the techniques used in the delivery of care. This collaborative requirement for successful telemedicine adoption differs from traditional views about the adoption of new technology, which focus only on the adopting organi-

zation. The need for mutual adaptation creates an extra barrier of complexity for telemedicine as an innovation.[39] For example, if the delivery organization and the provider organization operate in different countries with different cultures, medical norms, and operating systems, the complexity of adopting telemedicine is increased.[40] Such extensive mutual adaptation adds to the cost of the telemedicine system, making it harder to justify the relative advantage of the innovation versus existing procedures.

Moreover, at the institutional level, there may be significant conflict in regulating the use of a technology that has the potential to encourage the practice of medicine across regional and national boundaries.[41] Because telemedicine delivery requires close procedural coordination of the provider site and the delivery site, and the ability of telemedicine technology to span distance and time, any decision to adopt telemedicine as a delivery technology must address numerous institutional barriers to the free flow of health care services.[42] For example, physicians in one country or state may not be allowed to practice medicine in other countries or states. In diffusion terms, if these institutional barriers are strong, they will further limit the possible relative advantage to be derived from telemedicine and may mean that the practice of telemedicine will be considered incompatible with the existing system of medical practice in that country.

TOWARD UNDERSTANDING INTERNATIONAL TELEMEDICINE NETWORKS

A key question facing telemedicine researchers concerns the potential shapes of developing telemedicine networks. The nature of telemedicine as both a technology and a way of delivering care make the alliance and network analogies quite relevant for understanding how telemedicine might diffuse across borders. For over a decade, researchers have been studying the nature of strategic alliances and networks in health care delivery.[43] Researchers are trying to understand how alliances form, what structures are used to maintain these network organizations and potential effects of network membership on the organizations.[44] For example, McKinney, Kaluzny, and Zuckerman have speculated that managerial innovations would diffuse more extensively across networked organizations.[30]

In a related way, we are examining how a specific type of alliance, telemedicine collaboration, will be formed between organizations. First, telemedicine allows organizations to access skills and knowledge that may be far greater than their own. In our view, a key motivation for adopting telemedicine technology is the ability to access health care expertise that has already been developed at another institution. This kind of partnership can be cost-effective in that the delivery site institution does not have to develop its own knowledge-based infrastructure for all treatments, but can ration its resources and specialize in areas that are most needed. From this perspective the decision to adopt telemedicine becomes in essence a decision to outsource some expertise by the delivery site.

Cost versus Relative Advantage

Diffusion researchers from a communication perspective, from an economic perspective, and from a health care perspective argue that innovations are not adopted unless the potential adopters can see and understand that the new technology has sufficient relative advantage over existing technology.[28,30–32] The calculation of relative advantage is not a simple one for organizations. Relative advantage in its simplest form might only include operating efficiencies that reduce costs. In addition to cost savings, however, an adopting health care organization may be able to generate revenue through improved or new services that will also enter the calculation of relative advantage. As Rogers points out, if it only took relative advantage to diffuse an innovation, then diffusion would happen quickly over a wide range of organizations.[28] However, there is ample evidence that diffusion patterns are more varied than what might be predicted by relative advantage alone.[28,31,33] This is not surprising given the subjective nature—unique to each organization—of the calculation of how much relative advantage an innovation has to offer. As noted earlier, diffusion patterns also are affected by social factors such as the early adopter's prestige and the compatibility of the innovation with existing technology that contribute to the adoption of new technology by some organizations but not others.

In our view, a key motivation for adopting telemedicine technology is the ability to access health care expertise that has already been developed at another institution.

Specifically, telemedicine has a difficult relative value calculus. Organizations must consider whether their investment in telemedicine technology can be justified economically.[45] Governments pushed funding for telemedicine in part to overcome the relative disadvantage of having to add both a new technology and new procedures for delivering and receiving health care at a distance. Further complicating the relative value of telemedicine is the strong evidence of learning by medical personnel in sites that deliver or receive patient care via telemedicine. On the one hand, provider organizations learn by expanding their experience with rare or unusual medical conditions. On the other hand, delivery sites use telemedicine interactions to increase their absorptive capacity,[46] capturing the spillovers of knowledge from the provider as diagnosis and treatment are delivered by their own personnel under the direction of experts at the provider site.

Learning as a Relative Advantage

Telemedicine has a strong relative advantage over attempting to develop the same expertise in the delivery site for two key reasons: The expense of training skilled physicians and the delays that would result in delivering care due to the time it takes to develop expert skills.

Here is how these conditions might influence telemedicine in a potential cross-border alliance. Let us imagine a hospital with strong expertise in a medical specialty, such as infectious disease diagnosis and treatment. Also assume a moderately skilled but resource challenged hospital in a developing country such as Mexico. Physicians at the Mexican hospital may seek a relationship with the expert provider to deal with routine outbreaks of relatively rare diseases in the U.S. and Canada. The Mexican hospital—the delivery site—may be unable to fund or attract sufficient expertise to treat a large number of relatively rare diseases.

However, the Mexican physicians want to provide treatment to the victims and encourage relatively early adoption of telemedicine in their hospital. As a result, they can provide expert care without the delay inherent in developing expert physicians and staff. At the same time, the Mexican hospital becomes a test site for this new technology, and its personnel begin to learn as they act as conduits for the expert diagnosis and treatment recommendations from the provider. Over time, the Mexican hospital staff may become expert enough to pass along their expertise and form their own network with partners in Mexico and beyond, evolving into a provider organization.

This same logic of learning as a relative advantage would hold for health care organizations that are facing competing organizations with more advanced medical capabilities. To catch up, these late adopters of the medical capability can outsource some of their diagnostic and treatment services via telemedicine. This adoption strategy shortens the time needed to deliver patient care dramatically when compared to fully developing in-house capability. Using telemedicine, late adopters can catch up quickly with their competitors and in a manner that limits their financial investment in the new specialty and shortens the time it takes to be able to treat patients.

> *Proposition 1a:* Telemedicine relationships will be more likely to form between expert organizations and health care organizations that have an occasional need for that specialty but not enough demand to justify the investment in stand alone expertise.

Not surprisingly, an unusual spike in demand for specialized medical services currently unavailable from a local health care organization may lead to telemedicine adoption. A relative advantage of telemedicine technology is its ability to move expert knowledge to a remote site quickly while limiting the interruption to the routines of patients and provider organization personnel when compared to having to travel, reside, and practice in a foreign location. If crises occur frequently or are expected to have long-lasting effects, the cost of telemedicine may be justified when compared with the delays and costs associated with in-house development of medical services. This leads us to propose the following:

> *Proposition 1b:* Telemedicine relationships will be more likely to form between expert organizations and health care organizations that have exceptionally high demand—e.g., a crisis—that does not allow enough time to develop a capability in-house but will last long enough to justify investing in a telemedicine capability.

Learning as Competitive Advantage

Telemedicine collaborations may become part of the competitive strategies enacted by health care organizations. Patients in many countries may lack confidence in the ability of their local health care providers to deliver quality medical care or to provide adequate care in a timely manner. These patients often seek health

care from expert providers in other countries. For example, a number of well-known health care institutions use vacation-like advertising to reach private-pay customers in foreign countries to attract them to leave their countries and visit the U.S. for diagnosis and treatment.[47]

If we examine this example further, we can see how health care organizations may seek to retain their patients by developing capabilities that rival their U.S. competitors, initiating a competitive battle to retain the traveling patients. U.S. organizations that currently attract foreign patients would find telemedicine relationships with foreign health care organizations as potentially cannibalizing their foreign patient business. That is, the potential loss of revenues from foreign, often private pay patients makes it harder to justify the cost of telemedicine technology, thereby reducing the relative advantage of telemedicine, which leads to:

> *Proposition 2a:* Health care organizations that already attract foreign patients will avoid cannibalizing their patient base and not establish telemedicine relationships that decrease the need for people to travel.

We expect this condition to hold for specialties where travel is not medically dangerous, is relatively inexpensive, and is convenient. Where these conditions do not hold, there would be additional relative advantage for in-house development or telemedicine technology as the dangers associated with travel begin to outweigh the advantages of foreign health care delivery.

However, what if we assume health care organizations in the patients' home countries see the value in adding a medical specialty and begin to offer the services that their citizens currently must travel to receive? The travel expense and inconvenience associated with leaving the home country to receive care has a cost,[48] some of which could be avoided by using telemedicine in a partnership with a foreign hospital. Foreign health care organizations facing the loss of these lucrative traveling patients may see sufficient relative advantage to establish telemedicine-based relationships, thereby reducing the amount of patient travel, enabling the retention of some referrals, and providing skilled follow-on care in the traveler's home country via telemedicine.

> *Proposition 2b:* Foreign health care organizations that face the loss of traveling patients to competing organizations in the patients' home countries, will compete by forming telemedicine-based networks with home-country organizations, reducing the need for patients to travel.

Telemedicine would allow the foreign provider to retain the most difficult cases, deliver effective treatment, and minimize the investment in time, training, and technology needed by the home-country partner to care for these patients. We expect this condition to hold between organizations from countries with relatively high levels of medical skills and where travel is restricted or costs are high, providing significant cost savings and incentives for local services.

Social Ties and Telemedicine Network Structure

Another key question concerns determining the lines along which telemedicine relationships can be expected to form. Diffusion researchers have found that who adopts an innovation can have great effects on downstream adoption trends.[28] Adoption tends to be strong among individuals who maintain contact with people who champion or promote a new technology. This social connection is especially important in cases where the relative advantage of the new technology may be limited or of mixed value and where the technology is difficult to understand or implement. Relationships with innovation champions often are based on trust and improve the ability to communicate the innovation to others in the social network. If the champion or early adopter is of high social status, there is also a certain amount of prestige that accrues to the innovation. This status or perception then encourages further adoption.[28,31,33]

Changes in organizations are often developed via relationships maintained through personal contact between members of each organization in the network. There is also evidence of the economic importance of social ties maintained between immigrant populations and their country of origin.[49] Increased levels of bilateral trade between countries have been tied to the increase in their immigrant population.[50] Many medical experts have family origins in other countries and maintain significant social ties with family and colleagues in their native country. For example, there is anecdotal evidence of the importance of social ties in the establishment of transplant centers in Italy managed by U.S. university hospitals.[51] Based on emerging evidence, we expect social ties will affect the adoption of telemedicine and the direction of telemedicine-based relationship formation.[52–54]

> *Proposition 3a:* The presence of foreign nationals and/or foreign-trained medical personnel will make telemedicine-based collaboration with organizations in those foreign

countries more likely than collaboration with organizations in other countries. We expect this to relationship regardless of whether those personnel are located in provider or delivery organizations.

The experience of living and training in another country will increase awareness of both the capabilities of providers and the problems faced by care providers in the delivery sites. It should also help address the organizational inertia that slows the adoption of new technologies such as telemedicine. The passion and expertise of foreign nationals as champions with prestigious qualifications and as operational experts will help to overcome organizational inertia within the provider and delivery organizations. To overcome inertia, it will be necessary to create a sense of mission around the telemedicine project, and provide key professional and political relationships that can negotiate regulatory and cultural obstacles in both countries.

In addition, most of the early collaborative relationships formed will be between physicians at the delivery site with similar specialties who share social, professional, and cultural ties with specialists of that same type at the provider site. The technology and knowledge needed to deliver specialized services is often specific to a medical specialty—e.g. cardiology or radiology. Foreign experts will be crucial in showing the relative advantage of linking the organizations via telemedicine before provider organizations will adopt the new technology.[55] Ex-patriot personnel in the delivery organization will help pave the way for social acceptance of these experts and their knowledge of the delivery organization will be combined with provider knowledge of its health care system and culture. These elements will aid in creating a clear understanding of telemedicine and its compatibility with existing technology. Given these socially based knowledge ties we expect the following:

Proposition 3b: Early telemedicine collaboration between organizations in different countries will be limited to a single or a few medical specialties related to the individuals driving the telemedicine collaboration who have developed key social and professional ties between the organization members.

Knowledge Development and Structural Change

The adoption of new technology in health care settings can induce organizational changes.[56] From a governance perspective, the cooperative relationship needed to match the technology and expertise for delivering telemedicine services uses weak ties that are valuable in building cooperative relationships between organizations.[57] However, to deliver remote health care services effectively, strong operational ties are needed between the provider and delivery sites. These activities help build the absorptive capacity of both institutions, which facilitates learning from their experiences and the experiences of other institutions.[46] In telemedicine collaboration, the health care organization at the delivery site benefits from the accumulated expert knowledge of the consultants at the provider site and also learns during the health service delivery process.[58]

Provider experts will develop significant skills for improvising diagnostic and treatment procedures the more they interact with dissimilar levels of health care delivery sites via telemedicine. By their very nature, routine problems will not be the normal fare for treatment via international telemedicine. Moreover, nonroutine conditions will call for consultation and conditions at the delivery site that may be very different from what the provider site normally confronts. In a telemedicine context, consultants will have to adapt their routines based on the expertise and technology available at the delivery site, and the health service delivery staff will have to adapt their routines to accommodate the treatment needs expressed by the provider experts. This improvisation, or process of mutual adaptation occurring simultaneously,[59,60] will occur as telemedicine personnel at both provider and delivery sites coordinate their interactions and technology to deliver of health services. This unique colearning context of telemedicine leads us to advance the following proposition:

Proposition 4: Where the telemedicine partnership spans from an expert provider organization to a less sophisticated delivery site, both organizations will develop greater improvisational skills than will organizations involved in a telemedicine partnership consisting of peer-level partners.

There are also implications for the developing the careers of technicians employed at the delivery site organization. New job activities arise over time in response to the development and introduction of new technology. As these activities develop, members of a culture legitimize the activities as a form of work and these activities are "hived-off"[61] from an established profession, creating new professions.[62] Examples of this phenomenon among U.S. health care professionals

include medical technologists, registered nurses, and emergency medical technicians. In many cases, new occupations have been formed around the development of maintenance capabilities for newly developed technology.[62] The introduction of telemedicine may serve as an "environmental jolt"[63] that unfreezes the professional job structures and practices at the delivery site. This unfreezing will occur as a result of the need to provide the health care services recommended by the provider site. The provider will be a convenient, expert source of information on how to enact these recommendations. Institutional theory describes how organizations adopt structures that mimic powerful organizations in their environment.[64] Although strong operational ties may lead to isomorphism at the operational levels, the weak ties of a collaborative overall relationship are not as likely to affect delivery site governance mechanisms and structures.

Proposition 5: Over time, delivery site organizations will resemble provider organizations in their procedures and job activities in areas involved in telemedicine collaboration, but not in their overall structures or formal governance activities.

CONCLUSION AND IMPLICATIONS

Telemedicine has the potential to provide a uniquely effective and convenient method of international collaboration between institutions embedded in different national health care systems. A goal of this article was to explore some of the implications of the adoption of telemedicine capabilities and how the relationships involved in telemedicine collaboration may change the organizations involved in telemedicine networks. We have specifically explored what may lead organizations to adopt telemedicine, how adoption may lead to organizational learning, and the development of isomorphism in operations. There are additional areas that bear examination.

For example, telemedicine collaborations can be mutually beneficial exchanges of knowledge to develop partner absorptive capacity[46] and access to unique learning experiences and data. Indeed, if competition among health care organizations increases and governments permit more cross-border relationships among health care organizations, telemedicine may enable organizations to create knowledge-based relationships. These knowledge-based relationships would be invaluable as research and development incubators. For example, telemedicine partners could focus not only on providing health services, but also on co-developing new treatments and protocols for both exotic and chronic diseases. Moreover, such knowledge-based relationships would be very difficult for other competing organizations to imitate and could lead to sustainable competitive advantages.[27]

> *The introduction of telemedicine may serve as an "environmental jolt" that unfreezes the professional job structures and practices at the delivery site.*

Indeed, learning theory suggests that expert organizations seeking innovative medical treatments, protocols, and approaches should establish working relationships with a diverse set of health care organizations. Specifically, within dynamic environments, networks of organizations with loose ties are more likely to develop innovations than are tightly integrated organizational affiliations.[65-67] Following this logic, expert organizations should seek multiple foreign partners that have access not only to exotic remedies or to patients exposed to rare diseases, but also who possess nontraditional expertise in treating chronic as well acute conditions. Hence, telemedicine technology may provide a cost-effective method for facilitating these learning relationships.

However, based upon what we know about strategic alliances, telemedicine networks also should be subject to "lock-in and lock-out effects" and "learning races."[68] For example, leading expert organizations will attempt to lock-in relationships with the most desirable foreign partners, causing less desirable foreign organizations to be locked-out. At the same time, the network partners may engage in learning races, realizing that the benefits already accrued from information sharing outweigh the continuance of the alliance. That is, the partner who learns fastest and then severs the telemedicine relationship may gain a competitive advantage. These two factors suggest that successful telemedicine networks will require health service organizations with high levels of "alliance capability," expertise in managing relationships with multiple partners.[69]

In particular, we foresee telemedicine developing among international partners in multiple, yet patterned ways. Diffusion of telemedicine requires open trade and readiness upon the part of the medical

community. On the one hand, countries and health care organizations with sophisticated medical technology will attempt to export skilled services via telemedicine to less skilled nations and organizations. On the other hand, these same organizations with sophisticated medical technology are also likely to form partnerships with other expert organizations in distant and distinct markets. In either case, initial relationships among organizations are likely to be based on individual, trust-imbued relationships established through international medical training and exchanges.

Following the logics of network learning and strategic alliances, we speculate that the "expert-less skilled" partnerships are likely to be complementary, unstable, but innovation-producing relationships. In contrast, when each telemedicine partner's level of expertise is similar, competitive threats between partners such as "lock-in and lock-out effects" and "learning races"[68] would be more readily perceived. Hence, from the onset, telemedicine alliances between equals will more likely be exchange-based, stable, and convention-governed relationships.

In this article we have discussed the potential implications of forces that affect learning and diffusion of innovations in relation to the formation of telemedicine based networks. There is a great need to continue to pursue the study of how technology and collaboration may affect the future of health care. In particular, we encourage the exploration of the diffusion of telemedicine and how nongovernmental forces, such as competition and learning, may affect who adopts telemedicine technology and the uses of that technology for health care.

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